SCHOOL SCIENCE AND MATHEMATICS

Vol. XLIV | February, 1944 | Whole No. 382

THE 1943 AND 1944 CONVENTIONS

The 1943 annual convention of the Central Association of Science and Mathematics Teachers was planned strictly as a war emergency meeting. Under the able leadership of George K. Peterson of North High School of Sheboygan, Wisconsin, the program was developed in the direction of more effective teaching of science and mathematics in grades one through fourteen during the war period. In keeping with the times, only limited facilities were arranged for in the Palmer House. An attendance of over four hundred teachers, educational exhibits by many apparatus and book companies, and a program packed full of information and stimulation, all were a tribute to the careful planning that was done during the previous months.

Accepting the challenge of the future as presented by the resolutions committee, the Association has chosen for the theme of the 1944 annual meeting "Science and Mathematics in Post War Planning." Because of travel restrictions, the convention will again meet in Chicago. Emil L. Massey, Supervisor of Science Teaching in the City of Detroit, is the new president. Not only has he carried a great responsibility in the educational work in Detroit but he has also served on committees of state and national scope which have worked on the development of science teaching programs. Detroit has been well represented at previous conventions and a large group will accompany Mr. Massey to Chicago next Thanksgiving vacation.

George E. Hawkins, Lyons Junior College, LaGrange, Illinois, is the new vice-president. He has served the Association long and faithfully in many capacities. He is the chairman of the Journal Committee of the Association.

The Central Association of Science and Mathematics Teachers has made a unique and continued contribution to science and mathematics teaching in this country. Plan now to assist in every way possible to make the 1944 convention a success.

HAROLD H. METCALF, *Secretary*

SCIENCE QUESTIONS

Contributions are desired from teachers, pupils, classes and general readers. Send examination papers from any source whatsoever.

It is natural that questions connected with the War Effort will be especially appreciated.

Questions on any part of the field of science; questions having to do with the pedagogy of science; new applications of old ideas; present variations of perhaps ancient questions; anything that appeals to the reader, or might appeal to other readers—all are wanted.

What interests you, will most likely interest others also.

We will endeavor to obtain answers to all reasonable questions. It is always valuable to get questions whether we can get the answers or not.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Question Raisers and Answerers).

Classes and teachers are invited to join with others in this cooperative venture in science.

At the death of our late departmental editor, Mr. Franklin T. Jones, The SCIENCE QUESTIONS department was allowed to lapse. It will be continued if you want it. Please write the editor a letter stating what will be of most value to you. Indicate the type of changes you want.

ENROLLMENT IN HIGH SCHOOL

The enrollment in the public high schools for the year 1943–44 is 5,761,000, or about one million below the peak enrollment of 6,714,000 in 1940–41, a preliminary estimate made by the U. S. Office of Education of the Federal Security Agency indicates, the FSA said today.

The estimated present enrollment, made up of 2,701,000 boys and 3,060,000 girls, is approximately the same as the total in 1933–34. The 1943–44 enrollment is 6.2 per cent less than last year, and represents a drop of 246,000, or 8.3 per cent, among the boys and 135,000, or 4.2 per cent, among the girls.

Enrollments in the junior and senior classes of high schools have declined between 9 and 10 per cent since last year. The number of boys declined about 15 per cent, the number of girls about 5 per cent. This drop is probably accounted for by the large numbers of students who have left school for work in industry and for service in the armed forces.

The importance of completing their training is being continuously urged upon young people by Paul V. McNutt—who is concerned in the school-and-work problem both as Federal Security Administrator and as Chairman of the War Manpower Commission—by John W. Studebaker, U. S. Commissioner of Education, and by Katharine Lenroot, Chief of the Children's Bureau, U. S. Department of Labor.

MAP PROJECTIONS FOR AN AIR AGE

WALTER G. GINGERY
George Washington High School, Indianapolis, Indiana

For the purpose of any elementary discussion of map-making, the Earth is a sphere. The actual difference between the equatorial and polar diameters is about 1/300ths of the diameter. On a 16 inch globe this distance would amount to about .05 of an inch, an amount that could not be detected without careful measuring with instruments. The difference in elevation between the deepest depression and the highest elevation on the surface of the earth is only a fraction of the above amount which is negligible. This simplifies the map-makers' task. The fact, however, that a sphere is a non-developable surface makes for him a complicated problem.

A developable surface is one (like a cone or cylinder) that may be cut along some line and flattened out into a plane. No portion of the surface of a sphere can be flattened into a plane without stretching or tearing or compressing parts of it. It, therefore, is impossible to make, on a plane, an exact representation of any part of the earth's surface. The smaller the portion of the surface that is being mapped the less becomes the distortion due to this factor.

An ideal map would scale accurately in all directions and over all parts of the map. Equal areas of the surface mapped would be represented by equal areas on the map. The shortest distance between two points in a plane is a straight line. The shortest distance between two points on a sphere is a great circle. Hence, in the ideal map great circles should map into straight lines.

Two intersecting lines on the surface mapped would be represented on the map by two lines that make an angle equal to that made by the original lines. Since the earth has no "edge" to its surface the map should have no interruptions and no edge.

Since a sphere is not a developable surface, these qualities can not all be included in the same map. Various types of maps have been developed emphasizing certain of these characteristics at the expense of others. Unfortunately persons using maps have not always been aware of the characteristics that have been sacrificed and the maps have consequently contributed to

erroneous conceptions of the shape, proportion and direction of portions of the earth's surface.

Other factors also have contributed to these misconceptions of the geography. Columbus and Magellan convinced people that the earth is round by sailing east and west. The earth rotates from west to east on an axis which establishes poles, an equator and parallels and has led to the idea of circumnavigating it only by travelling east or west and not by passing around it from pole to pole. In fact circumnavigating in many peoples minds has come to mean only following a route that cuts all of the meridians regardless of how close to a pole it is done. According to this concept all one needs to do to circumnavigate the globe is to walk around either pole. There has been no corresponding tendency to think of circumnavigating the earth by going around it in any other direction. It would seem as reasonable to drive a stake at the intersection of Main and Market Streets in Midland City and claim that a route around this stake circumnavigates the earth as to claim that a route around one of the poles does, but it hasn't been done.

The polar regions have always been hostile so that no one wanted to go that way. Travel and hence our interest in geography was largely limited to the equatorial and temperate zones. This situation has promoted the use of maps that either did not represent at all the polar regions, or that made no attempt to represent them accurately. A subconscious result of the use of such maps is a concept of the earth as spread from east to west without interruption, but interrupted or indefinitely extended on the north and south. This is the concept of a cylindrical surface, and it is unconsciously held by many people who have the means of knowing otherwise when their conscious attention is directed to the problem.

Now, with the development of stratosphere flying the polar regions are no less navigable than other parts of the earth. Indeed, we are told that the stratosphere over the poles is reached at some five thousand feet while over the equatorial region it may be as much as twelve thousand feet high. Also the temperature of the lower layers of the stratosphere at the poles is higher than that of the corresponding layer in the tropics.

So long as travel and commerce were water or land born, our attention was necessarily directed toward sea lanes, navigable rivers and natural land routes. Locations of barriers almost universally prevented the use of the shortest routes between

places. Attention was not fixed on shortest routes and because the routes used were necessarily usually in the temperate or equatorial zones, these facts helped to fix the subconscious idea that the earth is a cylinder with indefinite boundaries at the ends.

Attempts at map making, of course, antedated the belief that the earth is a sphere. While the earth was flat it was quite simple to make a map. All that was needed was to secure the data and choose a scale of miles. If the data were accurate the map could be an exact representation of the area mapped. As has already been said, when the earth became a sphere, the problem became much more complex.

Among the early, successful attempts to represent large areas of the earth the Mercator projection ranks high, perhaps highest. A fairly close approximation to a Mercator projection can be obtained by circumscribing a circular cylinder about the earth, having the same axis as the earth, and of course, tangent to the earth at the equator. Using the center of the earth as center of projection the surface of the earth is projected outward upon the surface of the cylinder. The meridians project as elements of the cylinder equally spaced. The parallels project as circles parallel to the equator and since they are circles on a cylinder equal in length to the equator. The parallels are not equally spaced. The distance of any parallel from the equator on such a projection would be proportional to the tangent of the latitude. The poles will not project on the cylinder and the region immediately adjacent the poles is infinitely exaggerated. Such a cylinder could then be cut along any desired element and unrolled east and west into a rectangular map of all the world except that part near the poles.

The Mercator projection differs from such a projection only in the amount of exaggeration of the distance between the parallels. In this projection the north and south dimensions about any specified point are stretched an amount proportional to the stretching of the parallel through that point.

Figure 1 illustrates the development of a Mercator projection and indicates its cylindrical character.

On the Earth the length of a degree of longitude at a given point is equal to the length of a degree at the equator multiplied by the cosine of the latitude. On Mercator projection degrees of longitude are all equal regardless of latitude. Parallels are therefore stretched in proportion to the reciprocal of the

cosine of the latitude which is the secant of latitude. To maintain the shape of a given small area to be mapped the meridians must be stretched the same amount.

This property of the Mercator projection is by far its most valuable property. For any given small area it maintains exact shape. A result of this property is the fact that on a Mercator chart a path having a constant bearing is a straight line. In navigation such a path is called a rhumb line.

Since the only way to travel without reference to landmarks, i.e. by instrument navigation, is to start from some point and

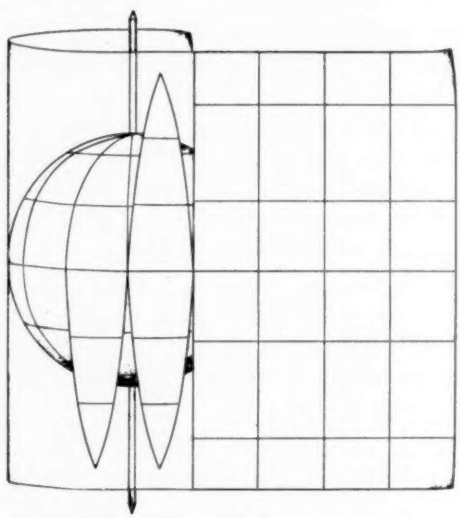


FIG. 1. The Mercator projection.

move, a given time at a given rate, in a given direction, all instrument navigation becomes *rhumb line* navigation and the rhumb line is a straight line on a Mercator projection.

Mercator charts are used by both marine and aerial navigators regularly in laying out courses.

For low latitudes the Mercator projection provides a map of very slight distortion.

Perhaps the second most popular type of projection for ordinary maps has been the Lambert. This projection is used to represent a portion, only, of the earth and that portion should lie all on one side of the equator. To construct this projection the north and south dimension of the area to be mapped is divided into sixths and a parallel is chosen one-sixth of the dis-

tance from the northern margin and another one-sixth from the southern margin. A right circular cone is then passed through these two parallels. The axis of this cone is the axis of the earth. Again the center of the earth is used as a center of projection to map the desired area on the surface of the cone. The meridians project into elements of the cone. The parallels project into circles on the cone parallel to the equator.

Figure 2 illustrates the development of this type of projection. When the cone is cut along one of its elements and flattened out the parallels become segments of circles with the vertex of the cone as center, while the meridians are radii of these circles. As a consequence the parallels and meridians intersect at right angles.

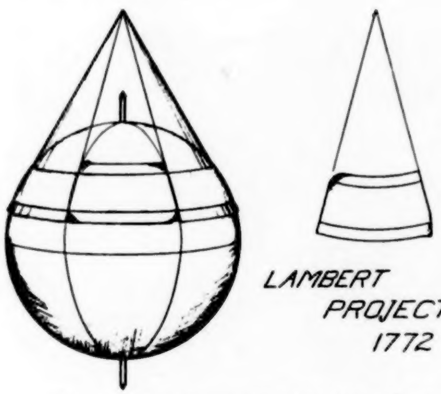


FIG. 2. Development of the Lambert projection.

For an area the size of the United States and located as the United States is, for example, this has been a very useful and very accurate type of projection. It is currently used in aerial navigation. The poles are not shown on such a map and hence the map contributes to the subconscious concept of the earth as a cylinder.

We may seem to be laboring this point, never-the-less it is an easily demonstrable fact that a large majority of educated adults unconsciously think of the earth that way. They know the Earth to be a sphere and will readily affirm the fact. However, if asked to indicate the direction from Chicago to a point 90° east of Chicago in longitude, and 10° south of Chicago in latitude they will point a little south of east; a direction that would be correct only if the earth were a cylinder.

Another type of projection that should not be omitted from any elementary discussion of the subject is the gnomonic. In this projection a plane is constructed tangent to the earth and a portion of the earth is projected upon the plane using the center of the earth as a center of projection. Since great circles on the earth are formed by planes passing through the center of the earth and these planes intersect the tangent plane in straight lines, the projection of a great circle on a gnomonic chart is a straight line. This is the one advantage of the gnomonic chart. Distances on the chart are exaggerated in proportion to the tangent of the angular distance from the point of tangency.

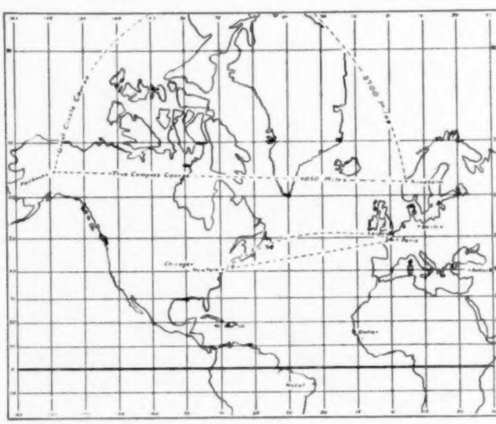


FIG. 3. A great circle on a Mercator map.

Navigators frequently start plotting a great circle course on a gnomonic chart. On this chart it is a straight line. This course is then transferred by points to a Mercator chart on which it usually becomes a curve. The curve is then divided into short cords which are rhumb lines. The distances and bearings of these rhumb lines can be approximated by divider, protractor and tables and the course is ready to be flown.

Figure 3 shows a Mercator map of North America and the North Atlantic. The true bearing course from Fairbanks, Alaska to Trondheim, Norway is shown as a straight line. Since the latitudes of these two cities are almost the same the course is almost due east. On the Earth this distance is approximately 4850 miles. Part of the great circle course is also shown. This is a curve extending north across the northern tip of Greenland and off the map. This distance is only approximately 3700 miles.

It is probably necessary to say that this is not a violation of the Euclidian axiom that a straight line is the shortest distance between two points. It is a consequence of the type of distortion employed in making the Mercator map.

The great circle course and the true bearing course for the Lindbergh flight from New York to Paris are also shown. Because this course is in lower latitude the distortion is less and the two courses are much nearer together than in the preceding example.

Figure 4 shows a gnomonic map of the same area shown in figure 3. On this map the great circle courses are straight lines while the true bearing courses are the curves. From this map it is much easier to believe that the great circle course is shorter.

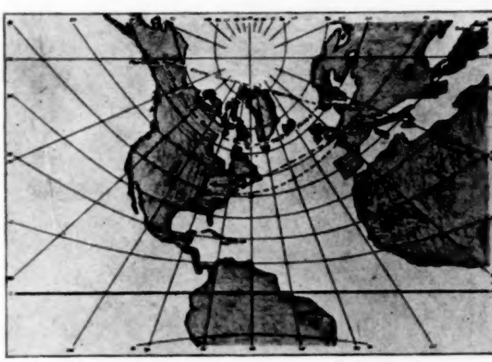


FIG. 4. A great circle on a Gnomonic map.

These figures illustrate the principle that before forming a concept from a map one should understand what property of the area mapped has been emphasized and what ones have been neglected or sacrificed.

In an effort to combat the cylindrical concept of the earth, modern air-minded geographers have used polar projections. Figure 5 is a polar equal-azimuthal projection. Such a projec ion centers on a pole. The parallels are circles equally spaced and the meridians are radii also equally spaced. This figure extends only to the equator. The projection may be made to cover any portion of the globe desired. It represents distances and directions from the pole exactly. If the projection is made to include the entire globe, one pole is expanded into the outer circumference and the map has no interruption and no edge.

The only scalable distance on such a map, however, is along

a radius or meridian. Distances along the parallels are exaggerated four and six tenths per cent at 30° from the pole, fifty-seven per cent at the equator and infinitely at the remote pole.

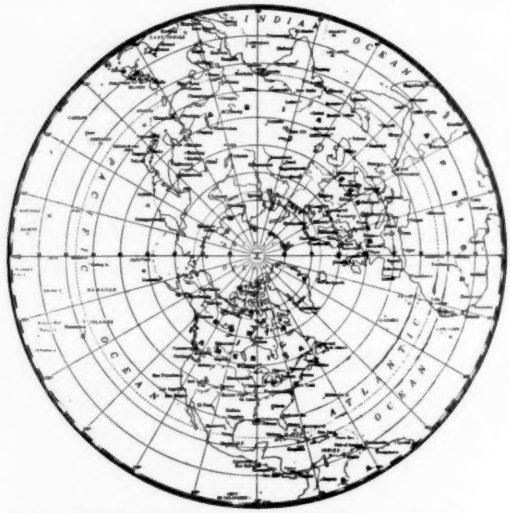


FIG. 5. A polar equal-azimuthal projection.

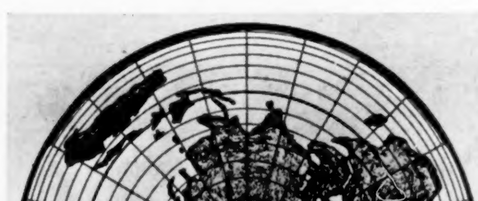


FIG. 6. A polar equal area map.

Equal azimuthal maps can be centered on any point on the globe and may then be used to represent the great circle distance and direction from this point to any other point. Such

maps have been constructed with centers at various cities for example Washington, D. C.

For some purposes it is important to show a map of the entire world and though the land masses be distorted as to shape exhibit them in their true proportionate area. Such maps are used to show population density, relative amounts of natural resources, etc.

Figure 6 is a polar equal area map of the whole world. To compensate for the exaggeration along the parallels of latitude the distances between these parallels is proportionately diminished. The southern continents are badly distorted and the Antarctic continent is spread entirely around the periphera of the map, but they all retain their true relative areas.

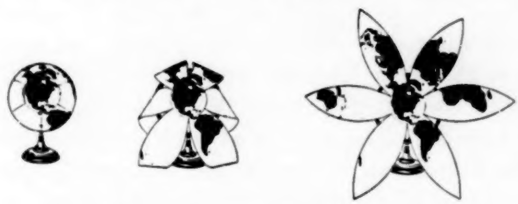


FIG. 7. Development of the Air-age map.

The projections described thus far have emphasized the earth's axis and equator as reference lines. They have usually placed the north pole at the top of the world and they have not furnished scalable great circle distances and directions. However, none of us lives at the north pole. We are beginning to realize that to understand our geography we must think from where we are to the other portions of the globe. There are several reasons why we must now think of these routes in terms of great circles and not of rhumb lines. Among these reasons are the fact that great circles on the earth are shortest lines between points, that air planes fly great circle routes and that short wave radio using directional aerials follows great circles. When we add to our thinking the prominence of the North American continent and particularly of the United States in world economics, commerce, invention and productivity, it becomes quite logical to construct a map with the United States as its central feature.

Chester H. Lawrence in New World Horizons writes "North America, and particularly the United States, has about all the natural advantages that could be hoped for. It has good harbors

on three sides, and numerous inland waterways are navigable. There are vast reaches of fertile land; even subtropical crops are produced. It has great deposits of coal and iron. Nations fight for oil fields; the United States has had petroleum to squander. The climate is favorable to man."

Figure 7 illustrates how a circle can be drawn about that part of a globe which has been chosen as the central feature of the map. From the center of this circle to the point diametrically opposite on the globe, great circles are drawn dividing the surface into six equal lunes. These lunes are then peeled from the globe starting from the remote vertex and peeling to the central circle. The map can then be flattened out with slight distortion yielding a figure shaped like a six petaled flower.

For the Air-Age map we have taken the intersection of the ninetieth meridian and the fortieth parallel as a center. This point is not far from Chicago and is also near the center of population of the United States. With this point as center we have drawn on the globe a circle with radius 30° of arc. This circle includes almost all of the North American continent. Beginning at a point diametrically opposite the center of this circle, that is, 90° east and 40° south, the surface of the globe has been divided into six equal lunes of angle 60° by great circles extending to the boundary of the above mentioned circle.

The central circle was made into a flat equal-azimuthal map by stretching slightly along the circumference. The maximum amount of this stretching is 4.6%. The lunes were also flattened into gores by stretching their margins uniformly. The amount of this stretch is 6.9% and is the maximum distortion occurring on the map.

The boundaries of the gores are great circles and of course are not straight. They, however, represent the greatest divergence from straight lines that any great circles make. The projection presents within the limits mentioned above a scalable map of the whole world so long as the distance scaled does not cross one of the interruptions.

It is a close approximation to an equal-azimuthal map for all points within the central circle. It is an equal area map within the limit of accuracy mentioned above.

Since meridians and parallels intersect at angles that are approximately right angles the map presents true shapes with a high degree of accuracy. It violates the canon that a map should have no edge or interruptions.

Children beginning the study of geography should be led to form correct initial concepts. They should be prevented from acquiring the erroneous ideas that the present generation of adults unconsciously hold. To do this the first world maps they use should be drawn to correct proportions, they should indicate great circle directions, at least, from the point where they are studied; and to be studied in America they should be centered on America. Later when polar, conical or cylindrical maps are introduced it should be done after carefully illustrating and understanding the types of distortion they produce.

AWARDS FOR RESEARCH

Pi Lambda Theta announces two awards of $400 each, to be granted on or before September 15, 1944, for significant research studies in education.

A study may be submitted by any individual whether or not engaged at present in educational work, or by any chapter or group of members of Pi Lambda Theta.

An unpublished study on any aspect of the professional problems of women may be submitted. No study granted an award shall become the property of Pi Lambda Theta, nor shall Pi Lambda Theta in any way restrict the subsequent publication of a study for which an award is granted, except that Pi Lambda Theta shall have the privilege of inserting an introductory statement in the printed form of any study for which an award is made.

Three copies of the final report of the completed research study shall be submitted to the Committee on Studies and Awards by August 1, 1944. Information concerning the awards and the form in which the final report shall be prepared will be furnished upon request. All inquiries should be addressed to the chairman of the Committee on Studies and Awards.

May Seagoe, University of California at Los Angeles, Los Angeles, California—*Chairman*
Margaret E. Bennett, Pasadena City Schools, Pasadena, California
Marguerite Hall, University of Michigan, Ann Arbor, Michigan
Katherine L. McLaughlin, University of California at Los Angeles, Los Angeles, California
Helen M. Walker, Teachers College, Columbia University, New York City
Elizabeth Woods, Los Angeles City Schools, Los Angeles, California

---

CHILDREN'S LIBRARIAN

Students, counselors, librarians, and others interested in library work will find helpful information in a six-page leaflet on "The Occupation of the Children's Librarian," by Sarah A. Beard, published by Occupational Index, Inc., at New York University. Single copies are 25¢, cash with order.

This is one of a series of 68 such leaflets describing opportunities in 68 different occupations. Each one covers the nature of the work, abilities and training required, income, and miscellaneous advantages and disadvantages.

LIFE IN THE DESERT HABITAT

John Y. Beaty*
Crystal Lake, Illinois

Many books and dictionaries have led us to believe that a desert is a barren place, where no person, animal, nor plant can live, but when we really study the desert, we find that it is full of life. There are flowers, trees, birds, reptiles, and mammals; and millions of people live on the desert and prefer it to any other place.

The desert is full of life but it is a special type of life. Animals must be adapted to the shortage of water and, usually, to the hot sunshine and dry air. However, some animals escape the hot sunshine by living underground or in protected places during the day and coming out only at night.

There are some flowers in bloom every month of the year in our own Southwestern deserts. For example, in April we may see blossoms of the desert star, desert gold, verbena, or desert mallow. In May we may see yellow buckwheat, alkali gold-fields, rock pink, mormon lily and others. There are flowers that blossom in June, some in July, some in August, some in September, some in October, some in November, some in December, and so on through the year. There are at least 764 different species of flowers in our Southwestern deserts; and probably the number is greater than that.

The most spectacular desert plant is the yucca. *Yucca elata* produces a tall spike of large beautiful white blossoms. An interesting thing about the yucca is that it cannot produce seed without a tiny little white moth called the yucca moth. Furthermore, the yucca moth cannot reproduce itself without the yucca plant.

Another popular desert blossom is the century plant, Agave. After growing for fifteen or twenty years, this plant sends up a tremendous stalk reaching a height of fifteen or twenty feet, and all around the upper part of this stalk grow clusters of large blossoms. After blossoming once and producing its seeds, the Agave dies. It was formerly thought that it took a hundred years

---

* Co-sponsor and member of party, Offield-Beaty Arizona Expedition of the Chicago Academy of Sciences 1940. Author of a number of school text books including *The River Book, The Mountain Book, Story Pictures of Transportation, Story Pictures of Our Neighbors, Story Pictures of Foods, Story Pictures of Farm Animals, Story Pictures of Farm Work.* Also: *Sharp Ears, the Baby Whale, Luther Burbank, Plant Magician, Nature Is Stranger Than Fiction.*

of growth before the seed was produced, but it is now known that it is only fifteen or twenty years.

There probably are no other flowers quite so spectacular in color and beauty as those of the cactus plants of the desert. Some are a creamy waxy color; some have bright red blossoms, and others have other colors. I have seen a cluster of Opuntia cacti literally covered from one end of the cluster to the other with bright yellow blossoms. Following these blossoms, fruits are produced which are almost as interesting as the flowers themselves. The Rainbow cactus produces a blossom almost as big as the cactus plant, and a bright crimson in color.

How can flowers thrive in the desert? Perhaps we first ought to make clear what a desert is. The simplest definition is this: A place where 10 inches or less of precipitation is experienced in one year. In Death Valley, California, less than two inches of rainfall is the average per year. There are a few deserts in which rain has never been known to fall.

It is lack of rain that makes the desert. Plants that grow in the desert, therefore, must adapt themselves to a shortage of water. Some have the ability to send roots great distances into the ground where ground water is found.

Others, such as the cacti, grow thick stems and slabs in which water is stored. Some plants produce almost no leaves, or none at all, and this prevents the loss of water. The cactus uses both of these devices. Most cacti have no leaves at all except the cotyledons which soon drop off. Some of the stems are in sections, and because some of these sections are flat, people have called them leaves. But actually, they are parts of the stem.

Having no leaves, there is less evaporation. Furthermore, the surface of the stems is so made that very little moisture escapes through the surface. Then, in addition to that, the cactus stores water—large quantities of it. Some cacti will live for three years without additional precipitation. It is true they do not grow during that time to any extent, but they at least survive.

There are also trees on the desert, and they, too, are strange trees. The paloverde, for example, has very few small leaves which stay on the tree only a short time. But the bark of the stems and trunk of the paloverde tree contains green chlorophyl which permits the tree to digest food without leaves.

The desert ironwood, the mesquite tree and the smoke tree all have few leaves, and those leaves are small. All of them, also, including the paloverde, have beautiful blossoms. The paloverde

in early Spring is covered with golden yellow blossoms. It is a beautiful sight. The smoke tree is covered with an indigo-blue blossom. It is, indeed, sometimes called the indigo bush. The blossoms of all of these trees are very similar to the blossoms of the garden pea. They belong to the same family.

It may be hard to believe that there are woodpeckers and hummingbirds in the desert. The woodpeckers are not the same kind we find elsewhere, but the hummingbirds are. The woodpecker has to have a special adaptation so far as his home is concerned, because there are not many trees in the desert large enough for a woodpecker's home. Consequently, the gila woodpecker digs holes in the giant Saguaro cactus.

This cactus grows to be 50 feet tall and as much as 24 inches in diameter. It has plenty of space inside for a woodpecker's nest. However, the inside of the cactus is very juicy. It is too wet a place for a bird's nest. So, the gila woodpecker digs several holes each year.

It must wait for a year for the cactus to grow a protective shell on the inside of a hole. The cactus grows this shell to prevent the escape of its own precious moisture, but the woodpecker benefits from the shell because it makes a dry place in which to build a nest. It does not go without a nest the first year, however, for there are other holes which were dug by other woodpeckers the year before. Because each woodpecker digs several holes each year, there is always one ready for a nest.

This woodpecker also gets a part of its drink from the cactus plant. When it digs a hole, it finds the juicy meat of the cactus, and this is both food and drink. Perhaps it is to get this moisture that the woodpecker digs several holes during the season.

The hummingbird feeds upon the insects and the nectar of the desert flowers. But, in addition, the hummingbird needs water. I watched a hummer one Sunday morning in Southern Arizona drinking from a little stream in the yard of one of the old Missions. It dropped to a point just above the surface, sucked up a quantity of water through its hollow tongue, and then hovered in the air above the stream. It then dropped to get more, never touching its feet to the water or to the ground.

These hummingbirds can fly long distances. They can go into the mountains which surround the desert, if necessary, but usually, they locate near a habitation where there is some water available. Also, they get some of their needed moisture from the insects which they eat in great quantities.

One of the other typical desert birds is the roadrunner. It is a rather large bird which does not fly but which can run as fast as a horse. It apparently depends for its moisture quite largely on the food it eats. Its food is made up almost entirely of lizards and snakes. A roadrunner has been photographed in the process of swallowing a rattlesnake.

Lizards and snakes are quite plentiful; they are not plentiful in the daytime, however; at any rate, they are not seen. They are under the ground or under stones where they must go to protect themselves from the hot sun.

Another interesting reptile is the desert tortoise. I captured one near Death Valley in 1941, and brought it home with me to Illinois. It eats only vegetable matter and very seldom drinks water. It does drink water, however, occasionally, but it has plenty of time to find it because it does not have to drink as often as many other animals do. It would be injured by the hot desert sun if it traveled during the daytime, so it comes out early in the evening, and hunts for food during the night, crawling into a hole or under a rock when the sun begins to be hot the next morning.

Those mammals of the desert which live on seed apparently do not drink water at all. For example, the kangaroo rat and many of the ground squirrels, while they live on dry seed, will not drink water. They apparently get their moisture as a result of the digestion of the food.

Those mammals which eat other animals such as the wolf, the fox and the badger get a great deal of the moisture from the bodies of the animals they eat.

Insects are plentiful on the desert. There are ants, beetles. butterflies, flies, bees, wasps and others. The plants are their source of food, and there are plants in all deserts except where the ground is covered with salt. These plants are not close together, for each plant must have a certain area from which to gather the precious moisture when it does come. But there are always plants in sight.

Perhaps the most beautiful bird of the desert is the Gamble's quail. It is not only a beautiful color, but it has two long feathers which project from the top of its head and bend forward. These feathers are thin and black and on the ends there are little racket-shaped puffs which make them most appealing.

There is life in the dry desert—plenty of it, both plant and animal. Somehow, it appears more interesting—more beautiful than similar life elsewhere.

LOOK AHEAD IN HIGH SCHOOL SCIENCE

ROBERT J. HAVIGHURST
University of Chicago, Chicago, Illinois

There is never any doubt about the problem of teaching science in war-time. The armed forces and industry state their needs, and the schools and colleges give them priority. They need the work of the science teacher; they say so, and the science teacher follows their directions. He feels sure that his work is important. He is never so free from doubt and self-criticism as when he is teaching in war-time.

What had to be done has been done by science teachers. The high schools have organized pre-induction courses, pre-flight courses, refresher courses. The colleges are full of boys studying mathematics, physics and chemistry for technical jobs in the armed forces. What had to be done has been done and I assume it will go on, as long as the need persists.

But what will happen when the war is over? The return of peace will make immediate large changes in science enrollment and in the teaching of science. Of the fact of change, we can be certain. Of the nature and direction of this change, we can guess, and perhaps we can do more than guess. Perhaps we can do something to control the nature and direction of post-war changes in science teaching. For this reason it may be useful for us to look ahead and attempt to foresee some of the coming opportunities and problems of science teachers.

Must we expect a reaction against the current popularity of physical science and mathematics? I think we must. I think we must expect enrollments in physics and advanced algebra and trigonometry to drop back to where they were before the war. There may be a general reaction against things associated with the war, which will turn people against science and cause a reduction even from pre-war enrollments. I do not expect this to happen, however, unless our teaching of science is completely wooden and unimaginative.

May we not rather expect a great popularization of science, similar to that which raised chemistry so high in public esteem after the first World War? No doubt the story of the part science is playing in the present war will be written as soon as military secrets can be revealed. This will be a story of great interest to scientists. Will it be equally interesting to the public? I think the answer to this question depends on whether science can be ex-

hibited as a Creator rather than a Destroyer. The book that did more than any other to popularize chemistry after the last war was Slosson's *Creative Chemistry*. Will the physics and mathematics of the present war have a record solely of destruction, or have they made great productive discoveries which can be used to create wealth and comfort for a poverty-stricken world once men can turn to productive enterprise again?

Will there be a shift away from interest in technology and toward interest in social and ethical problems? The war has put a premium on mechanical and industrial production, at the cost of a good deal of human liberty and comfort. After the war human well-being will be our dominant social concern. Such science and such technology as are conducive to human well-being will be in demand. This means biology, for certain. It also means physical science and mathematics, in so far as they can be related to our peace-time concerns.

We do not have to be prophets to foresee some of the major foci of public interest in the post-war world. I think we can predict with great certainty that the following five topics will be of general public interest.

1. *Health.* The public will be more than ever interested in problems of diet, public health, and extension of medical care.

2. *Housing.* There will be an immense housing boom as soon as the war is over. People will be interested in the new synthetic materials for floor-covering, interior decorating, screening, insulating, and so on. Problems of public housing, scientific, political and economic, will come up for discussion and political action.

3. *Employment.* It is likely that, in spite of the development of private enterprise and public work programs, there will be a substantial amount of unemployment. This unemployment, we know from experience, will hit young people hardest. Immediately the schools and other youth-serving agencies will be called upon to help boys and girls find useful experience outside of the regular labor market. We will not wait as long as we did during the last decade to provide agencies for giving work-experience to youth. No one has found a substitute for work-experience in the life of adolescent boys and girls, and no one is likely to. Therefore if the labor market will not take them, the schools and other agencies must help them get work-experience.

The science teacher can and should play an important part in the creation of work projects that will be of value to the com-

munity. Improving the parks, developing a community forest, building community canning and cold-storage facilities, equipping the school with motion picture and public-address facilities, constructing a community swimming pool, developing a summer camp-site, are projects which could go forward under the direction of science teachers with most of the work done by high-school students. Teachers with ideas for such projects and the ability to administer them will be in demand.

Another side to the employment problem is the need that industry will have increasingly for high-school graduates with enough technical training for jobs that need some scientific knowledge, but not a college course. This need will be met at first by men who have had training for technical jobs in the armed forces. But eventually the high schools may have to develop a kind of *vocational science* course intended to train boys and girls for technical jobs in local industry.

The need to develop vocational science courses may appear in quite a different form. If the government provides a substantial subsidy for demobilized soldiers who wish to pursue their education in school or college for a year or more, it seems certain that a large part of the task of providing such education will fall on high school teachers. While colleges will no doubt accept a large number of returned soldiers as students, it seems probable that the colleges will be swamped with students for several years after demobilization. Consequently the colleges will probably set up standards for admission that will keep out many men who have graduated from high school or have the equivalent of high school education through educational work done while in the armed forces. These men will turn to trade schools and technical institutes, which also will be swamped with students. Therefore the secondary schools will have both a responsibility and an opportunity to develop an instructional program to meet the needs of several hundred thousand young men. The science teachers may well take the lead by offering vocational science courses, related to job opportunities in neighboring industries.

4. *Conservation.* Although our productive plant promises us plenty when put to peace-time uses, we must be warned about the steady draining away of some of our natural resources. Petroleum is the outstanding example, but there will be others. It is an old story.

Three hundred years ago the greatest industry of North America was the fur trade. From the woods and down the rivers

came Indian canoes loaded with peltry, going east; east through the Great Lakes, sometimes in a procession three hundred in number; east to Quebec where tall ships waited to carry rich cargoes to Europe.

By the middle of the nineteenth century the fur trade had dwindled. The beaver were almost exterminated. A few years ago several state conservation commissions and the United States Department of the Interior began to trap beavers for another value than their peltry. Beavers were turned loose in sections of the country where erosion was going on and the water table was falling. Now their dams are once more catching the silt in the streams and holding back the water in natural swamp areas.

The same story can be repeated in a dozen forms. When the settlers first came to the Great Plains, they built their houses and stables out of the prairie sod, with its matted grass roots woven by the snows and summers of ten thousand years. It took four pairs of oxen and a heavy breaking plough to turn the first furrows in that prairie. Now all that is over, and we are trying to get grass to grow on the same land in place of desert sagebrush. In many counties of the North Central states a third of the topsoil has gone down the rivers to the sea in the past seventy-five years.

Now think about the timber lands. When Chicago and Milwaukee were trading posts on the Lake, Scandinavians came walking overland from the east and asked what lay beyond, to the west. "Woods, to the world's end" was the answer they got. These endless forests have been logged off in a few decades. The millionaire lumber kings have made their money and gone their way. They wasted seven-eighths of the timber to get the easiest and most profitable fraction. They left behind a country which has been plundered repeatedly by fire. They left a meager second-growth forest on land which was worthless for other purposes.[1]

The moral of all this can be told in a few words. It required a certain intelligence to exploit the stored-up resources of land, minerals, and animal life which the North American continent had been accumulating for centuries before the white man came. It requires a different kind of intelligence to make a fair trade with nature so that we and our children and our children's

[1] Walter Havighurst, *The Land and the People*. Lafayette, Indiana: Miscellaneous Bulletin of the Agricultural Extension Service, Purdue University, May, 1941. Pp. 14.

children may continue to draw our sustenance from the land. Beyond energy and a keen eye for profit, it requires cooperation, far-sightedness, and understanding of the processes of nature. One man alone cannot use the land and its resources wisely. He must collaborate with his grandparents and with his grandchildren. He must also collaborate with his fellow citizens in framing a wise social policy, based on scientific study.

In our country where the majority of young people get a high-school education, one of our obligations as educators is to see that these young people learn how to use and how to conserve our national wealth. This can hardly be done unless the science teacher becomes a central figure in the effort.

5. *Peace.* When the war is over we shall have to make and keep peace. After the statesmen have done their part, the school-teachers will have a job to do. They will have to help American boys and girls understand the causes of war and the sacrifices which Americans will have to make in order to preserve peace. While the principal responsibility will rest upon teachers of the social sciences, I think that teachers of the natural sciences can do much to help boys and girls understand enough about race to prevent them from swallowing racial theories that serve to bring on war, and to lay a basis for understanding of the interdependence of people from the four quarters of the earth.

These are some of the things about which Americans will be concerned in the post-war years. They are social problems. But they are also problems which cannot be solved without the wider extension of scientific knowledge. I think it is not too much to say that unless science teachers do their share in preparing boys and girls to meet these problems, the problems will not be solved in any satisfactory way.

What I have said thus far has dealt with problems that we face, and that science teaching can help us to solve. But science teaching should also serve to remind boys and girls of problems already solved, and benefits already obtained from science. If we could not look back over a history of betterment of human life through science, I think we might lack faith and assurance to go ahead with science to the solution of future problems as they arise.

The science teacher should always teach that science has made two fundamental contributions to modern life.

Science has given man the choice between want and abundance.

Science has freed man from irrational fear.

The material and the intellectual progress of man through the centuries has been bound up with a growing control over Nature and understanding of natural processes. Man has conquered want through scientific agriculture, through exploitation of minerals and other raw materials, and through the control and use of natural energy. Man has not quite conquered fear, but through science he has freed himself from the tyranny of ancient superstition, and through science he is gradually coming to understand his own inner fears. The scientific conception of the nature of the world and of man can free man's mind just as the scientific control of matter and energy has freed his hands.

I hope we may never forget these things in our teaching of science and I hope that our students may learn them well. As we look to the future and teach young people to apply scientific knowledge to the problems of the future, we and they can gain assurance from the past.

JAPANESE-HELD CULTIVATED RUBBER LANDS MAY ONCE MORE BECOME OVERGROWN JUNGLE LANDS

Japanese-held cultivated rubber lands may once more become overgrown jungles unless, as is considered improbable, they receive constant and painstaking care, it is pointed out in *Industrial and Engineering Chemistry*.

The tropical nature of the rubber-growing country fosters the growth of jungle plants, creating an imminent threat to any cultivated land in that region. Although the Hevea trees now cultivated are to a large extent resistant to blights and pests, they are not immune, and if neglected will succumb.

"The conquerors of Malaya and Singapore came into sudden possession of rubber stocks far beyond their capacity to fabricate and consume," the journal reports. "In this situation no reason has existed for them to exercise the scrupulous care necessary to keep the trees in continuing productive health."

Neglect for even the short period since the fall of Singapore can cause substantial damage to the value of these lands, and if continued, provides a relatively greater hazard.

SUGAR INDUSTRY AND MIT JOIN IN FIVE YEAR RESEARCH PROGRAM

Sugar will be the research subject of a group of scientists at the Massachusetts Institute of Technology during the next five years as the result of a long-range $125,000 program entered into by MIT and the newly established Sugar Research Foundation of New York. The investigations are expected to lead to new and important uses for sugar and its numerous relatives in the carbohydrate family.

FUNCTIONAL DISEASES IN RELATION TO HUMAN INDIVIDUALITIES*

S. William Becker, M.S., M.D.
Chicago, Illinois

Before the significance of the term "functional disease" can be appreciated, it will be advantageous to trace the development of ancient and modern concepts of disease and to review the types of disease now recognized. The ancients thought that all diseases resulted from the presence of evil spirits or from the action of superhuman enemies. In an endeavor to cure the victims, their medicine men attempted to cajole, frighten or placate such spirits. Modern developments in medical treatment convince us that such rituals could not have had a true therapeutic effect beyond that recognized as psychotherapeutic. Individuals were accustomed to wear amulets in the form of ornaments, gems, scrolls or relics, often inscribed with symbols, to protect themselves against disease. Such amulets, still worn by more primitive people, can have only a psychotherapeutic influence.

Hippocrates (460–377 B.C.), the Greek physician who is known as the father of modern medicine, was the first to suggest that diseases were not due to evil spirits, but rather to altered physiologic processes. He also emphasized the causative and precipitating effect of climatic influences on persons with certain diseases. This relation, rather neglected for a long time, is now being restudied and is more and more appreciated, especially in connection with functional diseases. Dr. Friedrich Hoffmann (1660–1742) believed that the nervous system was concerned in many diseases, in that life was movement and death cessation of movement. Movement, of course, is a direct result of nervous impulses. This neural concept was furthered by William Cullen (1712–1790), one of the founders of the University of Glasgow Medical School, who believed that the tonus of the body depended on energy emanating from the central nervous system. It was only in quite modern times that physicians, notably Sir Thomas Albutt (1836–1926) wrote extensively on functional disease.

Definition of Disease

A question now to be considered is: "What is disease?" The

* From the Section of Dermatology, School of Medicine, University of Chicago. Read at the Annual Convention of the Central Association of Science and Mathematics Teachers, Inc., Chicago, Ill., Nov. 26, 1943.

author's own preference is for a definition by the late Dr. A. S. Warthin, Professor of Pathology at the University of Michigan, who defined disease as "life (for without life there can be no disease—author) altered from the normal in time, place or degree." If abnormal changes in bodily tissues can be demonstrated by clinical or laboratory methods, the disease is known as "organic." If no such change can be demonstrated, it is known as "functional."

Organic diseases may be inherited or acquired. An inherited disease is known as an hereditary disease, and is a constitutional abnormality that is transmitted from parent to offspring by virtue of alteration in the parent's germ plasm. Many such disorders are subject to definite laws of heredity, so that their appearance can be predicted with a fair degree of certainty. Acquired organic diseases may result from a variety of injurious agents. Among them are physical agents and chemical substances, living organisms of both plant and animal origin which produce infection and infestation respectively, and tumor cells which are operative in neoplasia. Organic diseases may be acquired by anyone, although there is some slight variation in susceptibility depending on age, body build and race. Any tissue or organ in any part of the body can be involved. The severity of the disease depends on the part of the body attacked (the more vital the organ the more serious the disease) and, in case of infections and some infestations, the resistance offered by the patient. Organic diseases are liable to be serious, so serious in fact that they may at times destroy life itself. The agents which produce organic disease are tangible and can usually be demonstrated by appropriate clinical or laboratory methods. If they are living substances, they often can be grown artificially and studied in vitro and in laboratory animals, during which studies biological preparations have been elaborated for the efficacious treatment of the patient.

Functional Disease

Functional diseases, on the other hand, cannot be acquired by everyone. Although legally all men may be free and equal, from the biological viewpoint individuals differ greatly. Some of them are potential candidates for functional diseases; others are not. Just as in the case of organic diseases, functional diseases, also, may occur in many different parts of the body. While it is impractical to enumerate all functional diseases, the following

will give a good idea of the most common ones. Many nervous phenomena, some of which are called "nervous breakdown," migraine (sick) headaches, various nervous habits, including stammering, are usually functional diseases. In the field of the heart and blood vessels (cardiovascular system), the condition known as irritable heart or soldier heart is probably the most common. High blood pressure (hypertension) and some transient strokes of paralysis also may be functional. Certain diseases of the stomach and intestines are on a functional basis in many instances. They include loss of appetite, ulcers of the stomach and duodenum, certain types of colitis and some of gastroenteritis. In the respiratory system, certain cases of perennial hay fever, in which the patient has symptoms of rhinitis throughout the entire year with no proven allergic cause, and some instances of asthma are included in the functional group. In the genitourinary field, bed wetting, frequency or urination, impotence and amenorrhea are frequently functional in nature. Certain cases of arthritis are also included in the group. In the dermatological field, many of the harmless but stubborn inflammatory diseases of the skin cannot be proven to have an organic cause. Among them are the ones usually called "chronic eczema" and many that have been thought to be caused by fungus. The latter are included in the group of inflammatory disorders of the feet which have been called "athlete's foot." Careful study has shown that a majority of such eruptions are not really fungous infections, but rather belong in the group of functional diseases of the skin.

In contrast to organic diseases, functional diseases are relatively harmless. Only rarely, and then usually as a result of secondary organic changes, do they become so severe as to threaten life. However, they cause an untold amount of suffering, most of which can be prevented by application of a few comparatively simple treatment measures. In contrast to diseases of organic causation, the precipitating and causative agents of functional disease are intangible, a factor which has prevented accurate understanding of the fundamental mechanisms which underly them. The data which are presented in the following paragraphs, while somewhat intangible, have been invaluable when translated into therapeutic methods and, in the present state of our knowledge, must suffice. It is within the realm of probability that the mechanisms of production of functional diseases will be much better understood in the future.

Allergic diseases, too, should be mentioned here, because they have a definite relation to both organic and functional diseases and, as a matter of fact, stand midway between them. Their similarity to the former lies in the fact that they are produced by tangible agents, usually protein in nature, to which the patient has become allergic as the result of previous exposure. On the other hand, not everyone can become allergic as the result of such contact as is experienced in ordinary daily activities. The type of person who becomes allergic is the same type that is vulnerable to functional diseases. Allergic diseases display an added similarity to functional diseases in that, while they cause much discomfort and misery, they are only rarely serious.

Type of Person that Is Vulnerable

What kind of individuals are apt to be victims of functional diseases? Our earliest data are obtained in retrospect by questioning the mother of a child that presents such a disorder. When asked relative to prenatal activity, the information is usually obtained that the child has been overactive before birth. This phenomenon is explained by assuming that, as soon as cerebral cells have made functional connection with voluntary muscles (at about the fourth month of intrauterine life), the latter are bombarded with impulses which result in muscular contraction, experienced by the mother as fetal movements. Such movements are normal during the latter part of pregnancy, but ordinarily are not excessive in degree. On account of this fetal overactivity, many such mothers have had considerable difficulty in obtaining adequate rest during the final weeks of pregnancy. It is assumed that such cerebral overactivity noted before birth is a manifestation of protoplasmic unrest which is present not only in the cerebral cells, where it results in overactivity and exhaustion, but in all cells of the body. In some tissues, such as the connective tissues, bones, etc., such restlessness is not evident, but in the more antigenic tissues, namely the skin and mucous membranes, it is manifest in the ready antigenic response to antigens. This response results in the formation of antibodies, a characteristic which results in allergic diseases, which occur more frequently in such persons than in the more indifferent, lazy ones.

After birth, the overactive brain continues to bombard the body with impulses, which are obeyed up to the age of cooperation, at about 15 years, unless the child is treated. This activity,

of course, demands an overuse of energy and the child is soon "in the red" with respect to his energy balance sheet. This overactivity may be the only abnormal manifestation, in which event it is known as "nervousness in childhood." On the other hand, the child may show signs and symptoms of functional disease.

As these individuals become older, they may be divided into two groups. The members of the first group are overactive both physically and mentally. This combined overactivity may be manifested in the form of excessive conversation and emotional outbursts. In the second group, the overactivity is confined largely to the mental sphere. Such persons are quiet physically, read a great deal and, even though they react just as strongly to external influences, they manage to conceal the exaggerated emotional reactions. Stokes has described this type of person by stating that the front of his house appears normal, but he is always "hollering down his back stairs."

In adult life, persons who are prominent candidates for functional and allergic diseases are usually energetic and hard working. As a result of stimulation by their own brains and on the part of their parents, they strive for good grades and try to get their names on honor rolls. However, their attention is held with difficulty because their minds wander, hence their accomplishments may be very spotty. They often excell in subjects they like and do poorly in the ones that do not appeal to them. They are usually honest to a fault and are dreamers and inventors rather than backslappers and politicians. They want to do everything they see and to do it better than anyone else. They overload their programs so that they are forever rushing, always behind trying to get caught up. They are alert at bedtime and feel tired only when it is time to get up in the morning. Perhaps because of their superior brains, they engage in mental rather than physical work, consequently they are usually small boned and not very husky. They fatigue easily when carrying out manual labor.

Such persons usually have a few good friends, chosen for their mental ability. They seldom drink or smoke. They tend to be inhibited and lack the spontaneity of less serious individuals. They are inclined to take themselves too seriously and do not enjoy frivolity. They often work by fits and starts; periods of overwork "when the spirit moves them" are followed by spells of loafing. They work themselves up to positions involving responsibility, perform their duties well, but wear themselves out

doing them. Many such persons are salesmen and school teachers.

Just as such people are overactive, they are also over-sensitive. Agreeable sensations elate them to an unwarranted degree and disagreeable ones overdepress them. Such exaggerated sensations evoke abnormally strong emotional reactions. Such persons are inclined to be idealistic and perfectionistic, hence strive to be "one hundred percenters." It is the author's opinion that it is impossible to be a one hundred percenter without developing functional or allergic disease. Such a complication is inevitable in our northern climate. If one moves to a subtropical latitude to improve one's health, the climate exerts a favorable influence on, and may even cure the functional disease, but affects adversely one's perfectionistic accomplishments and one ceases to be a one hundred percenter.

In addition to the predisposing effect of the inherited prepared soil in the form of nervous overactivity and oversensitivity, there are several factors which operate in precipitating the functional disease. Already overstimulated by his own brain, such a person grows up in a stimulating environment, since both parents are of the same overactive type. In the northern United States, both the rapid tempo and the climatic changes, especially the sudden drops in barometric pressure, are stimulating. Such climatic changes occur more frequently in the winter, hence functional diseases are seen more frequently during that season. The artificial social life is more demanding than the more natural social existence of a generation or two ago. Social evolution has outstepped natural evolution. Nature has not yet had time to adjust human beings to the added strain of modern life.

Diagnosis

When a patient with functional disease presents himself to a physician complaining of discomfort or even pain (and such sensations are just as disagreeable as though they were produced by organic disease), the doctor can often discover no abnormalities by ordinary methods of examination. The observing physician, however, will already have noted the strong grip of the patient's sweaty palm along with his overactivity during ordinary conversation, and can make use of special tests for functional disease if he desires. He will question the patient for social difficulties. Family history reveals that the mother and/or the father, usually both, have the hyperactive, hypersensitive makeup.

Social studies have been made by several researchers. Dr. H. Canby Robinson, lecturer in Medicine at Johns Hopkins University Medical School, stated: "Emotional disturbances form the elements of illness next in importance to organic disease, and are closely related to the social and personal status of the patient. They demand for their understanding a knowledge of the strains and dissatisfactions under which people live and the conditions under which physical disability has to be endured." At the University of Chicago Clinics, a study was carried out by Misses Hiett and Petersen on fifty patients with functional diseases of the skin. Fifty patients with cutaneous organic diseases were used as controls. Thirty-six of the fifty patients with functional diseases were found to have definite social changes immediately preceding the onset of the disorder, as follows:

Twelve, onset of the eruption associated with change in the family constellation.

Ten, onset associated with the sexual function or adjustment to the marital situation.

Six, onset associated with adjustment to work, school, or the standards of a new country.

Four, onset related to economic insecurity.

Four, onset associated with physical trauma.

Two had skin disease since infancy.

Twelve, no change in social status at time of onset. Of the fifty controls, only seven patients associated the onset of the disease with change in social status, as compared with 36 of the patients with functional diseases of the skin. The patients with functional cutaneous disorders experienced a feeling of tension during meals and during attempts to fall asleep in a much higher percentage than did those with the organic diseases.

Treatment

After careful study has eliminated organic disease, the patient is told that his disorder can be explained on an energy basis. He is told that he has been born with a nervous system comparable to a 100 horse power engine in a chassis designed for one of 40 horse power. The high powered engine has exhausted the body but, since he does not have a normal sense of fatigue, he does not have a brake on his activities. The products of exhaustion, instead of stimulating nerve pathways which would make him feel tired, have stimulated other pathways which convey impulses to the part of the body involved in the functional disease. Just

what happens when such aberrant impulses reach the various organs is not known, but Sir Henry Dale and Dr. Otto Loewi shared the Nobel prize in Science in 1935 for their epoch making discovery that nerve impulses are effective through the action of chemical substances which are liberated at the synapses (relay points) and endings of the nerves. Various chemical substances could produce the signs and symptoms of functional disease. For instance, histamine might be produced in the skin. Injection of histamine into the normal skin always produces a wheal identical to that seen in urticaria (hives). Since the disease represents perverted fatigue, the individual is told to do what he would do if he felt tired, namely—to regulate his activities.

Social factors are investigated and corrected where possible. Overwork is eliminated and regular habits of rest are advised. Since such persons are brainy types, eight hours' sleep and an extra hour for a nap during the day are prescribed. If hours of work interfere with a nap in the daytime, an hour can be devoted to this purpose before or after dinner at night. Because functional diseases are less frequent in sunny climes and in the summer in the North, the patient is advised to purchase a sunshine lamp, to which the entire body is exposed every night. Regular vacations are prescribed, to be spent in resting rather than in activity. Diversion is often mistaken for rest.

Emphasis is placed on the necessity for discounting the exaggerated sensations which the individual receives too strongly because of the hypersensitive nervous system. This procedure reduces the height of the peaks of elation and the depth of the troughs of despair, so that the existence curve more nearly approaches a straight line. The person is advised to develop patience, tolerance and selfishness. A mild sedative, given temporarily, aids in accomplishing this goal.

After the general procedures enumerated in the preceding few paragraphs have been instituted, specific treatment is directed toward the organ or organs involved. Such therapy is purely medical and is not within the scope of this paper.

If the person with functional disease will depart from his family tradition of "battling things down," and resign himself to a regime of, for him, regulation of activities, if he will shift from a "one hundred percenter" to a "ninety percenter," he will obtain relief, his efficiency will improve, and he will become a healthier and happier individual.

NON-DESTRUCTIVE TESTING BY THE MAGNETIC PARTICLE AND FLUORESCENT PENETRANT METHODS[1,2]

ROBERT C. EICHIN
Magnaflux Corporation, Chicago, Illinois

With the increase in production of high speed motor parts and the added service demands made upon these engines, it has become essential to know with at least a fair degree of certainty that the integral parts which go into each engine are as nearly perfect from the standpoint of metallurgy and machining as is possible. The development of a positive, rapid, non-destructive means of testing parts which would detect defects in the three following classes: non-metallic segregations; forging, quenching, and grinding cracks; and fatigue or strain cracks has helped to improve the performance and increase the life expectancy of equipment today.

These non-destructive tests are not limited in their applications to aircraft parts; however, some ammunition and gun parts are subjected to the tests as are cannon, truck and tank parts, ships and ship fittings. A complete list of the applications of the magnetic particle and fluorescent penetrant methods of non-destructive testing would be too long for presentation here.

MAGNETIC PARTICLE INSPECTION METHOD

The Magnetic Particle Inspection Method, commonly called Magnaflux, is a rapid, non-destructive test for magnetic metal parts. Due to the principles upon which this method is based, its use is restricted to metals which can be magnetized, namely: iron, steel, nickel, and cobalt. It is not applicable to the large field of non-ferrous metals nor to most of the stainless steel alloys.

In the Magnetic Particle Inspection Method, the part to be inspected must be magnetized by passing a high amperage, low voltage current through or around the part setting up magnetic lines of force in the part. Any interruption in the magnetic field due to a crack, seam or inclusion at or near the surface of the part will set up a magnetic leakage field or magnetic poles at

[1] Delivered at the Physics Section of the Central Association of Science and Mathematics Teachers November 26, 1943.

[2] Methods frequently identified as Magnaflux and Zyglo, which are trade names, Reg. U.S. Pat. Off. by Magnaflux Corporation.

the boundaries of the discontinuities. If finely divided ferro-magnetic particles are introduced onto the surface of the magnetized part, they will gather at such leakage points indicating the presence of a leakage field in the part.

There are five fundamental steps necessary for all magnetic particle inspection: 1. Magnetizing the part. 2. Introduction to the surface of the part of ferro-magnetic particles. 3. Visual examination for presence of accumulations of the particles. 4. Determination of the cause of indication. 5. Evaluation of severity of defect. The sequence of the first three of these steps may be varied depending upon the type of steel in the part and the sensitivity required.

In magnetizing the part, the direction of the flow of the magnetic lines of force is of utmost importance. It has been found that defects show up best when they are approximately at right angles to the magnetic flow. Most parts to be inspected are usually magnetized and examined at least twice. Passing a current directly through the part sets up a circular magnetic field which will show defects running the length of the part. In order to show up defects at right angles to the part, it may be placed in a coil which sets up longitudinal magnetic lines of force. In most applications direct current is applied because it is possible to obtain deeper penetration of the metal; however, certain types of defects such as fatigue cracks can be adequately detected by the use of alternating current for magnetizing purposes. The length of the flow of the magnetizing current is usually very brief, a one-half second is sufficient in most applications.

The ferro-magnetic particles introduced to the surface of the magnetized part are chosen for particle size and shape and permeability. They are coated to give color contrast with the part to be inspected and this coating acts as a partial insulator. The particles may be dusted on in the dry form or they may be placed in suspension in a light oil. The use of the wet or dry method is usually determined by the type of part, the size of the part and the type of the defect likely to be found. When the particles are introduced to the surface of the part while the magnetizing current flows, the inspection is said to be of the continuous type. If the part is magnetized and then brought into contact with the particles, it is known as the residual method.

The visual examination of the part, after it has been mag-

netized and the particles brought into contact with it, is of the utmost importance. So far, no satisfactory method has been devised for removing the human element from this part of the inspection method. Good eyesight, adequate light and a conscientious operator are essential factors.

After a part has been examined by the Magnetic Particle Inspection Method, it is frequently desirable to demagnetize the part before putting it into use or carrying on further machine operations. If this is not done, it is likely that difficulties may be incurred in subsequent machining operations or in the case of the examination of the finished part, the magnetic field remaining in it may seriously affect its functioning.

With this inspection method, it is possible to ascertain at which stage in the manufacture of a part the defects occur; for example, some parts which require numerous steps in their manufacture are checked several times along the production line. It is not infrequent that the bar stock, forging or casting is inspected before any machining operations are performed. Since some defects may be introduced in a grinding or heat treating process, inspections are sometimes made before and after these operations. Usually it is possible to localize the source of the defects, remedy the procedure and eliminate a large percentage of defects due to the manufacturing process.

A good example of the use of the method may be seen in the field of aircraft engine parts. All magnetizable parts are inspected at least once before they are assembled in the motor. Most parts are checked many more times. A highly stressed aircraft gear, for instance, is often inspected at each of the following stages in its fabrication; in the billet, after the gear blank is forged, after rough machining, after finish machining, after rough grinding, and after the finish grinding. If there is a large percentage of defective parts found at any inspection step, the preceding operations are carefully observed to ascertain the cause of these defects. In this way much valuable machining time can be saved because several hours of machining and grinding will not be put into a part which had a defect introduced in one of the earliest stages. When the aircraft engine is assembled it is placed in a test block and run for a period of time. This is known as the "green run." The engine is then completely disassembled and all magnetizable parts again inspected by the magnetic particle inspection method. Defective

parts are replaced and the engine is reassembled and run again before being accepted as usable.

In general it is safe to say that if a part can be magnetized, it can be inspected by the Magnetic Particle Inspection Method. Large vessels such as boilers, oil stills, pipe lines, etc., are checked in sections so that the size of the part does not limit its inspectability.

There is available to industry a new type of ferro-magnetic particle known as Magnaglo. These ferro-magnetic particles which are used in the wet bath have a fluorescent coating. The magnetic inspection is carried on in the same manner but the visual examination is done under a black light. Any indications which are formed by an interruption in the magnetic field cause a gathering of the fluorescence coated particles; and when viewed under the black light, these indications glow with a bluish green light.

This type of magnetic particle makes possible a much more rapid examination of complex parts such as coil springs. Since the indications are formed by the magnetic principle, the use of this method is limited to magnetizable metals.

The Fluorescent Penetrant Inspection Method

The fluorescent penetrant inspection method is applicable to all solid materials, metals, plastics, ceramics and glass and is not limited as is the Magnetic Particle Inspection Method. The one limiting factor in this method is that the defects to be detected must be open to the surface. However, by inspection and analysis, it has been found that frequently there is a direct and positive correlation between surface and sub-surface conditions. In aluminum castings, for instance, sub-surface porosity is usually accompanied by evidences of that porosity at the surface.

In the Zyglo method, the part to be inspected is dipped or painted with a water-emulsifiable, highly fluorescent penetrant. The penetrant is allowed to remain on the surface of the part for a period of time depending upon the type of material inspected. In order to inspect for porosity in aluminum and magnesium, a penetration period of a few minutes is adequate. Steel and stainless steel usually require somewhere in the neighborhood of two hours of penetration time and tungsten requires twelve hours. The length of the penetration period depends upon the type of material to be inspected and also the

type of defects sought. During the penetration period, the penetrant finds and penetrates into any and all fissures in the material. The part is next washed in a water stream which removes the surface penetrant from the part. It is then dried either by the application of heat or by using air or towels. The purpose of the drying step is merely to remove the presence of the water used in the washing process.

The washed and dried part is then dipped into a developing agent which tends to act as a blotter to draw back to the surface any penetrant which may have entered into the metal. When the part is examined under a black light, any penetrant which has found cracks fluoresces with a bluish green color indicating the presence of the defect in the surface. "Black light" is the term popularly applied to the invisible radiant energy in that portion of the ultra-violet spectrum just beyond the blue of the visible spectrum. The visible spectrum ranges roughly between 4,000 and 8,000 Angstrom units in wave length. The black light range is between 3,000 and 4,000 Angstrom units in wave length. This black light is not to be confused with the ranges of ultra-violet used for therapeutic, sterilization, germicidal and health purposes, which are below 3,000 A.U. and which are potentially harmful to the eye in varying degree.

The Zyglo inspection method has a number of very interesting applications and it is very likely that a large number of new uses for the method will be found in the future. One general use has been in the field of testing for leaks in vessels and containers of various sorts. It is possible to paint or cover the inside surface of a vessel with the penetrant and examine the outside surface with a black light. If there are any leaks, the penetrant will seep through and fluoresce on the opposite side. The method is now in use on several types of glass parts and has proved very satisfactory.

It is possible to use this method as a laboratory tool for purifying production methods or it can be used directly in the production line. Some foundries use the Zyglo method on the first runs of castings in order to ascertain optimum gate and vent locations.

Stresscoat

A method for analyzing the distribution, direction and value of local strains in any structure by means of the formation of characteristic crack patterns in a brittle coating applied to its

surface is known as Stresscoat. Stresscoat is not a non-destructive test method, it is a design tool. With Stresscoat, it is possible to ascertain the exact location of stressed areas in a part; and by changing its design, arrive at a shape which is more economical and safe. This Stresscoat method is largely a design tool which enables an engineer to accurately check the efficiency of the design of a part.

By means of this method, for example, a propeller hub weighing 63 lbs. was reduced to 47 lbs. by removing excess material at areas of low stress. This weight reduction becomes a vital factor in the aircraft field where each pound that can be taken from the weight of the airplane may be added to the load-carrying ability of the plane.

The Stresscoat method consists in coating the part with a brittle lacquer chosen from a group of lacquers depending upon the temperature and humidity of the test area and part. The part is then stressed as it would be in operation and the formation of the cracks in the lacquer observed. Cracks occur first in areas of high stress. In parts which are too large for actual testing on them, it is possible to use plastic models. If desired, it is possible to measure the stress quantitatively by means of the use of a calibration strip subjected to a known load.

Summary

Non-destructive tests have come to occupy an increasingly important position in industry. By means of them, it has become possible to improve the quality of finished parts and also to discover where in the process of manufacture defects are created. They have taken a place in the writing of specifications for quality and must be recognized as a factor of quality production by designer, manufacturer, and user.

NEW FILMS

A new series of 150 16-mm sound motion pictures on machine shop, lens grinding, ship building, and use of the slide rule has been announced by the U. S. Office of Education. Authorized by Congress, these films are designed to speed up the training of hundreds and thousands of workers in war industry.

This series supplements the 50 training films already released more than a year ago. The success of the first series has been worldwide. More than 3,000,000 persons have seen each of the 50 training films. About 1000 prints are now in use in Africa. Others have gone to Latin America, China, Australia, and India. Twenty-four prints have been flown to the U.S.S.R.

ARCHIMEDES AND MATHEMATICS

H. T. Davis
Northwestern University, Evanston, Illinois

In order that we may gain some understanding of the background of Archimedes, we shall present him as a guest of honor at a dinner given by King Ptolemy Philadelphus in the royal palace in Alexandria in the year 250 B.C. The famous Museum, founded by the king's father, Philadelphus Soter, had flourished magnificently for more than half a century. Under the patronage of the Ptolemies it had acquired a library of approximately 400,000 volumes. Although Euclid, the first professor of mathematics in the Museum, had died by this time, the faculty in the year of our dinner was undoubtedly the most distingusihed one ever gathered together in the ancient world. Although the dinner is a fiction, no liberties have been taken with the facts and all the persons present are historical characters contemporary with Archimedes.

The Guests Assemble

A few nights ago we met in the Museum a distinguished stranger from Syracuse. His name was Archimedes and he was introduced to us as a friend and relative of King Hiero of that illustrious city. That he is regarded here in Alexandria as a man of more than ordinary worth is attested by a letter which has just arrived for us from the Royal Palace; for in this letter King Ptolemy Philadelphus has invited us to be present at an informal dinner which he is giving in honor of the distinguished visitor.

Since this is the year 250 B.C., Philadelphus, the great patron of the arts and sciences, has been upon his throne for thirty-five years, and during this period the affairs of the Museum have greatly prospered. The king himself is now nearing the age of sixty, but although he suffers considerably from the gout, he still retains a lively interest in the affairs of the mind. Queen Arsinoe has been dead these twenty years or more, and the occasional state affairs held in the Royal Quarters lack the sparkle and the zest which her striking personality once gave to them. In his declining years the king has become fonder of these quiet parties where small groups of chosen friends can survey the affairs of the busy world. It is fortunate, indeed, that this powerful and wealthy monarch finds pleasures in association

with great scholars, a phenomenon with few parallels in the history of empires.

Since this is to be a feast of reason rather than a trencherman's festival, the guests assemble in a private room in the Royal Palace. As we are ushered in, we find that Archimedes has arrived before us and he and the king are busily engaged with a set of ivory blocks. "May the gods bring a plague upon your trick," mutters the king. "But show me not how it goes, my friend from Syracuse, for it will help to wile away some of my tedious hours." With these words the king sweeps the blocks into a silver bowl and rises to receive us.

"Archimedes has just been showing me one of his puzzles," says Philadelphus. "He wants me to fit these fourteen figures into this square box. He tells me that each of these ivory demons represents some multiple of the one forty-eighth part of the square itself. If I ever get the key to the puzzle, I shall have rare fun with the dioketes, who has been giving himself airs of late."

This puzzle of Archimedes appears to have been the first of that long succession of cut-out games, which have amused the human race through the centuries. It apparently remained in vogue for many years and the name *loculus Archimedes*, or box of Archimedes, seems to have been used to represent any cleverly fashioned puzzle. But whether this invention adds luster to the name of the great scholar for all of that the reader must decide for himself.

The guests are now assembling and we find that two of the most distinguished literary characters of the day have been invited. The first of these is Theocritus, father of pastoral poetry, an elderly man now well past sixty, the ancestor, as it were, of that long succession of writers who in every age have invoked the sylvan muse. The second is Callimachus, the all-powerful president of the Museum, and the dictator of letters among the Alexandrians.

Conon, the astronomer, presently makes his appearance for he is one of the most intimate friends of Archimedes. Conon in later years gained great prestige in Alexandria by suggesting that the stolen tresses of Queen Berenice, wife of the third Ptolemy, had been transported to the sky. And, indeed, the delicate network of stars which lies within the area formed by Ursa Major, Boötes, Virgo, and Leo is still known as the *Hair of Berenice* (*Coma Berenices*).

"And here is Eratosthenes," said the king, "who is soon to leave us for the shrines of Athens. I envy him the trip and may the gods prosper him on his journey."

Eratosthenes was in high favor with the king for he had undertaken the task of writing the biography of Queen Arsinoe. Eratosthenes, known as the wise man of Alexandria because of his knowledge of many things, was later to gain immortality by measuring the circumference of the earth. He is known to mathematicians for his famous sieve by means of which prime numbers can be separated from the sequence of the integers, and for an ingenious solution of the ancient problem of the duplication of the cube. At the time of the king's dinner he was twenty-six years of age.

Two men of mature years now enter the room and they are greeted with great respect by the king. "I suppose that you haven't yet found the reasons why men grow old nor why I suffer the pangs of torment in my legs," said Philadelphus jestingly. "My friends, to most of you the names of Erasistratus and Eudemus need no introduction. But to the others who come from a distance, let me present Erasistratus, who knows more about what goes on within our bodies than the priests in the temples, and his colleague, Eudemus, who wields the sacrificial knife, but who looks at the viscera of his victims with an eye to what he sees and not the omens that they portend."

You may well believe that we regard these men with deep interest for Erasistratus was the founder of the science of Physiology, while Eudemus was the successor of Herophilus, the founder of Anatomy, in the days of the Museum under the first Ptolemy.

Two other guests now arrive and they are greeted cordially by Archimedes. "I have not yet paid my respects to you during this visit of mine in Alexandria," he says, "for you are ever busy with your observation of the sky. What new things have you now to tell us?"

"Curious matters there are among the stars," one of them replies, "but only patient measurement will tell us their secrets." These men, we understand, are Timocharis and Aristyllus, able astronomers, who are mapping the heavens and fixing the places of the stars by a system of their own devising. In a later century their careful work was to prove of inestimable value to Hipparchus in his profound studies upon which so much of modern

astronomy has been founded. Hipparchus discovered the precession of the equinoxes by comparing the position of the bright star Spica as observed by Tiomocharis between 285 B.C. and 283 B.C. with his own observations.

Several other guests now enter the room and among them are two whom Archimedes greets with special interest and affection. Their names, we learn, are Zeuxippus and Dositheus, and they carry on the mathematical tradition established by the great geometer Euclid. We did not know the nature of their special interests, but they were regarded so highly by Archimedes that several of his treatises were later dedicated to them.

"I am sorry," said the king, "that Ctesibius cannot be with us tonight, but he is away on certain affairs of state. You know that he has an ingenuity second to none, and he is contriving certain machines of war which will greatly concern our enemies, if they are rash enough to attack us. The god Hephaestus himself would envy his workshop and his forges. But our guest of honor is also wise in these matters, as I hear from our colleague Hiero, and perhaps later he can be prevailed upon to tell us something of them."

We chat a while and the king keeps his eye impatiently upon the door. Suddenly there is a clatter outside and in a moment a young man nearing thirty hurries into the room. "I beg your pardon, father," he says, "but I tarried too long at the harbor. 'Tis a wondrous ship that King Hiero has just sent in and I have spent the afternoon examining its handy devices. It is the very ship, I understand, that Archimedes launched so wondrously a short while ago."

Philadelphus greets the young man affectionately, and with obvious pride presents him to us. "This, as most of you know, is my son," says the king. "Since my eyes grow dim and my legs feeble, the time draws near when he must carry on our work. My father took a special pride in the Museum; he learned the value of wisdom from Alexander, who discovered it on his part from Aristotle. And now one sees how important it is that the torch be passed along to younger hands. It is my wish that the next Ptolemy will continue the tradition established by his grandfather, and that he will keep the torch burning brightly in the years to come. It is for this reason, my friends, that I have asked him here tonight to dine with us so that he may learn the ways of scholars like yourselves."

Archimedes Discourses on an Apple

With these fine sentiments, which, we may add, were well heeded by the prince, who under the name of Euergetes, that is to say, the Benefactor, continued in later years the patronage of his predecessors, the company is now ushered into the dining hall. Washing our hands in the golden bowls provided for us, we take our places upon the comfortable couches. Philadelphus presides over the gathering with the prince on one side and Archimedes on the other. Although the banquet provided for us is in keeping with the customary lavishness of the court, we note that the king partakes sparingly of the dishes set before him and dines mainly on lentil porridge.

"It has come to my ears," says the king to Archimedes, "that you have just made a discovery which you regard very highly. It concerns a figure like this apple here; but perhaps you will be good enough to tell us what more you can say, than that it is round like the moon."

At this the face of Archimedes lights up with pleasure, for of all the things that he has discovered this touches his pride the most.

"There is much more in the matter than mere roundness," says Archimedes. "For, suppose that one considers this apple completely enveloped by a cylinder, the top and bottom touching as well as the curved surface. What now can one say about the volumes of the sphere and its container, as well as about the area of the two surfaces?"

Although the answer to this problem can be obtained readily enough today by any school boy, it presented real difficulties in that distant time. For the first man who tried it, without the tools of modern mathematics at his disposal, found the road beset with thorns.

"The answer to this puzzle," says Archimedes, "is both beautiful and surprising. For both the volume and the surface of the sphere are two-thirds of the volume and the surface of the circumscribing cylinder. In connection with this study I have also been considering another matter, namely, the ratio of the circumference of the circle to its diameter. All of you know that this number is more than three but less than four, but who among you can tell me by what portion of the whole it exceeds three?"

Today, by modern methods as elegant as they are powerful, we could answer the question of Archimedes by citing the deci-

mal approximation of this ratio, our familiar number π to the unbelievable value of 707 decimals. But the first mathematicians struggled valiantly to attain a fair estimate of this important number. By obtaining the lengths of polygons inscribed and circumscribed about a circle, Archimedes finally concluded that "the circumference of a circle exceeds three times its diameter by a part which is less than 1/7 but more than 10/71 of the diameter." In terms of this magic number, then, Archimedes was able to give the volume and the surface of the sphere. His own estimate of the elegance of these results is seen in the following quotation from Plutarch:[1]

> And although he made many excellent discoveries, he is said to have asked his kinsmen and friends to place over the grave where he should be buried a cylinder enclosing a sphere, with an inscription giving the proportion by which the containing solid exceeds the contained.

Centuries later Cicero found the tomb of the great scientist covered over with brambles and neglected by the people of Syracuse. The account, as given in the *Tusculan Disputations*,[2] is worth repeating here:

> When I was quaestor I tracked out his grave, which was unknown to the Syracusans (as they totally denied its existence), and found it enclosed all round and covered with brambles and thickets; for I remembered certain doggerel lines inscribed, as I had heard, upon his tomb, which stated that a sphere along with a cylinder had been set up on the top of his grave. Accordingly, after taking a good look all around (for there are a great quantity of graves at the Agrigentine Gate), I noticed a small column rising a little above the bushes, on which there was a figure of a sphere and a cylinder. And so I at once said to the Syracusans (I had their leading man with me) that I believed it was the very thing of which I was in search. Slaves were sent in with sickles who cleared the ground of obstacles, and when a passage to the place was opened we approached the pedestal fronting us; the epigram was traceable with about half the lines legible, as the latter portion was worn away. So you see, one of the most famous cities of Greece, once indeed a great school of learning as well, would have been ignorant of the tomb of its most ingenious citizen, had not a man of Arpinum (Cicero) pointed it out.

Archimedes Discusses Some Very Large Numbers

"I have heard recently that you have made some attempts to measure the grains of sand in the universe, and also in the sphere of the fixed stars," interposed Zeuxippus. "Can you tell us something of these computations, Archimedes?"

It will be observed from this that among the ancient astronomers the word universe was used technically to mean the

[1] *Life of Marcellus*, xvi.
[2] v, 23.

sphere which contained the earth at its center and had a radius equal to the distance to the sun.

"The difficulty with this problem," replies the mathematician, "is found in the size of the numbers. For as you know we have given names to numbers only up to a myriad (10,000), and this, while it may estimate the size of armies, is a very feeble tool when we are talking about the distances of the stars. But of course we can still speak of a myriad of myriads (100,000,000), which give me a set of numbers that I shall call numbers of the first order."

"Such thoughts make my head whirl," says the king.

"But now if we take a myriad of myriads as the unit of the second order, then a unit of this unit will carry us to a unit of the third order, if you follow me. We can, as you clearly observe, form a myriad of myriads of such orders, and then we shall have a number of such vast proportions that it should measure all things in the universe."

"However, even this some day might not suffice for us," objects Zeuxippus. "Then your system would need to be revised."

"An excellent objection," replies Archimedes, "and I have given thought to this also. For when we reach a myriad of myriad of orders, then this vast number I have called a unit of the first order of the second period of numbers. And when I have reached the myriad of myriad of such numbers, then the new unit will start another series. This new quantity I have called the unit of the second order of the second period. And even the gods themselves could probably find nothing to measure with the unit of the myriad of myriads order of the myriad of myriads period, and with that I have concluded my scheme."

There is dead silence in the room when Archimedes finishes his survey of his astonishing system of numbers. For what, indeed, could be measured with this vast unit? For the last number in the last order, if written out in our own decimal system, would start with 1 and be followed by eighty quadrillons, that is to say, 80,000 million millions, of cyphers. Even the most extravagant demands of modern cosmology, let us say the expression of the radius of space in terms of the radius of the electron, or the enumeration of all the electrons in the universe, would find this scheme of Archimedes sufficient for its purpose. However, if one assumes a modern estimate that the number of electrons in the universe is of the order of 10^{83}, then the number

of possible permutations of this swarm of particles would make necessary the addition of a third category to the Archimedean scheme. That the concept of such immense numbers has already claimed one victim we now observe; for poor Theocritus is dozing over his wine.

On the Grains of Sand in the Universe

"This is interesting, indeed," says Conon, "and astronomy has need for such a system. But I am sure that all of us would like to know how you use it in finding the number of grains of sand in the universe by your sand-reckoner."

"Here I must make some assumptions," says Archimedes. "I shall use very fine sand, for I shall think of a poppy-seed, let us say in diameter not less than one-fortieth of a finger-breadth, as containing a myriad (10,000) grains of sand. Since the volumes of spheres are to each other as the triplicate ratio (cubes) of their diameters, we see that a sphere of diameter equal to the breadth of one's finger will contain something around 64,000 poppy-seeds, or six units of the second order and 4000 myriads of the first order grains of sand."

"My head still whirls," says the king.

"Since we need a stylus and a waxen tablet to show these next estimates, I shall merely give you the final answer. If we use my figure of 10,000 earth-diameters as the diameter of the universe, then the number of grains of sand which would be contained therein is less than 1000 units of the seventh order of numbers (or 10^{51}). And then, if we finally employ a sphere of the size attributed by Aristarchus to the sphere of the fixed stars (10^4 universe-diameters), the number of grains of sand would be less than a thousand myriads of units of the eighth order of numbers (or 10^{63})."

Archimedes now fixes his eye upon Eratosthenes. "You may have use some day for these large values. I have a problem to propose to you. It concerns a vast herd of cattle that once filled the plains of Thrinakia, stretching away as far as the eye could see them. In this herd there were bulls of four colors and cows of four colors and the relation of the numbers in each group I shall give you at another time. I may say, however, that the sum of the white bulls and the black bulls forms a perfect square, while the sum of the yellow and the dappled bulls is a triangular number like 3, 6, 10, and so on."

This famous "cattle-problem" of Archimedes was notable

for two things. First, it was the predecessor of that long line of numerical puzzles which involved the solution of equations in terms of integers alone. Second, the answer to the problem was unbelievably large, since to enumerate the number of animals in each of the eight categories, there would be required something like 660 pages, each containing 2500 figures. That Archimedes, or the unfortunate Eratosthenes to whom the problem was proposed, ever achieved the solution may be justly doubted; that they developed a method for solving it is possible.

For those who wish a more detailed account of the ingenious system of numbers devised by Archimedes and his computation of the number of grains of sand in the universe, the following explanation in symbolic terms may be useful:

Since a myriad is 10^4, which we designate by m, a myriad of myriads is $m^2 = 10^8$, a number which we designate by M. This is the fundamental unit of the Archimedean system and it is called by him the unit of the first order. Similarly the number M^2 is the unit of the second order, M^3 the unit of the third order, etc. The unit of the Mth order, namely, M^M, is given a new designation, being termed the unit of the first period. If we denote this number by P, then MP is the unit of the first order of the first period, M^2P the unit of the second order of the first period, etc., until we reach P^2, which is called the unit of the second period. Proceeding in this manner we come finally to the number P^M, which Archimedes calls the unit of the myriad of myriad order of the myriad of myriads period. This unit, which we shall designate by R, is thus seen to be $R = P^M = (M^M)^M = M^{M^2}$. In order to count its digits we form the logarithm of R and thus have

$$\log R = M^2 \log M = 8 \cdot (10)^{16} = 80{,}000{,}000{,}000{,}000{,}000.$$

In modern notation the computation of the grains of sand in the universe proceeds as follows:

Archimedes assumed that one poppy-seed contained a myriad of grains of sand, $m = 10^4$, and that one poppy-seed had a diameter equal to one-fortieth of one digit (finger). Hence, in a sphere of diameter equal to one digit, there will be $(40)^3 \cdot 10^4 = 64 \cdot 10^7$ grains of sand. This is less than 10^9. Since m digits = one stadium, we thus find that there will be less than $m^3 \cdot 10^9 = 10^{21}$ grains of sand in a sphere of radius equal to one stadium.

Archimedes then introduced his assumption regarding cosmic distances, which may be stated in the following ratios:

$$\frac{\text{Diameter of the globe of the stars}}{\text{Diameter of the sun's orbit}}$$

$$=\frac{\text{Diameter of the sun's orbit}}{\text{Diameter of the earth}}=m.$$

Making a gross over-estimate, Archimedes then assumed that the diameter of the earth was less than 10^6 stadia. (It is actually about $7\cdot 10^4$ stadia). Hence, noting that the diameter of the sun's orbit was also called the diameter of the universe, we obtain the inequalities:

Universe-diameter $< m\cdot 10^6 = 10^{10}$; globe-of-stars-diameter $< m^2\cdot 10^6 = 10^{14}$.

From these inequalities it follows that the number of grains of sand in the universe is less than $10^{21}\cdot 10^{30} = 10^{51}$, and the number of grains of sand in the globe of the stars is less than $10^{21}\cdot 10^{42} = 10^{63}$. Since the first of these numbers is equal to $10^3\cdot M^6$, and the second is $10^7\cdot M^7$, it is clear that they belong to the sixth and seventh orders of the Archimedean numbers respectively. For other details the reader is referred to T. L. Heath: *The Works of Archimedes*, Cambridge, 1897, clxxxvi+326 pp.

For the actual equations of the cattle problem, one may consult either the volume by Heath just cited, or F. Cajori: *A History of Mathematics*, New York, 1931, pp. 59–60.

(*To be continued*)

"WHERE DOLLARS MAKE SENSE"

How adequate schools, adequately euipped, and better paid teachers bring a dollar and cents return to community, state and nation, is the theme of a new sound motion picture, "Where Dollars Make Sense." Production of this motion picture has been assigned to The Jam Handy Organization, Detroit, Mich., by its sponsors—The National School Service Institute of Chicago.

Upon completion, prints or copies in 16 mm. will be made available for showings before special groups, including PTA, business men's and business women's clubs and organizations, tax-payers, and civic groups. The picture dramatizes the new and growing needs of schools to provide the kind of education the community must have to meet the new demands inevitable in the postwar world.

CAN CONCEPTS IN ELEMENTARY MATHEMATICS BE DEVELOPED?

John T. Johnson
Chicago Teachers College, Chicago, Illinois

The title of this report was first, Can concepts in arithmetic be taught? Then upon consideration of the question whether anything can be taught and not learned, the title was changed to, Can concepts in arithmetic be learned? Then upon further discussion, the chairman of this section seemed to think that we do not learn concepts because concepts are developed. Hence the title was changed to the present form. After the writer had begun a closer study of this concept in mathematics in an attempt at making a test for measuring it the title had to undergo a further development. The writer is primarily interested in how well children of the upper grammar grades learn the concepts after the teachers think they have taught them. So a more fitting title, or it may be considered a sub title, is, To what degree can concepts in elementary mathematics be developed?

Before this question can be answered there is a previous question that must be answered and that is, To what degree *have* concepts in elementary mathematics been developed? This is the question the writer has attempted to answer in this experiment. It was not an easy task. A test had to be made that would test for concepts only. Someone may say, why not ask for definitions of the things for which concepts are wanted? This would not be sufficient for children may be able to give definitions from memory without knowing the concept or they may know the concept and not be able to give the correct definition. This brings to mind an exercise that the writer has frequently indulged in when talking about concepts in education and psychology. This may be a question in psychology as much as it is in mathematics. The exercise used with college and high school students is to ask for the definition of a chair. If you ask any number of high school or college students to write down the definition of a chair you will get correct responses from less than one per cent of them. The definitions you get generally run something like this. A chair is a piece of furniture to sit on. A chair is a seat with legs to sit on. A chair is a piece of furniture that has a back, seat and legs. None of these are correct definitions of a chair and yet we would not say that these people do not have the concept of a chair. A definition must be inclusive and also exclusive at the

same time. The definition of a chair must include all chairs and at the same time exclude all things that are not chairs. The above definitions do not exclude sofas and davenports and other similar furniture. It is possible then to have a correct concept and yet not be able to define the thing you have a concept of. To satisfy the curious the correct definition of a chair is given by Webster in, "A chair is a single movable seat with a back." You see it does not have to have legs in order to be a chair but it must be single, it must be movable and it must have a back.

May we say then that the ability to define correctly represents the acme or apex of the development of the concept. It may be added that this apex is seldom reached by any one with respect to any concept. We have now the two ends of the conceptual development, the zero end and the other end. What we mean by the concept of anything is perhaps reached long before the correct definition stage. Hence we cannot expect a child in the sixth or seventh grade to give the correct definition of a fraction say for it takes a rather high degree of maturity to be able to formulate a correct definition as has been seen. The concept of a fraction is reached some time before the definition stage but when. There was a time in arithmetic when we started with the definition and the pupil memorized it first before he studied the thing he memorized the definition of. Some of you remember, a quarter of a century ago, when the definition of a fraction was given at the beginning of the discussion as, A fraction is one or more of the equal parts of a unit. This may have some merit, at least to some pupils, but we now think of the definition as coming at the end of a series of learning steps about either a concept or a process. The above, however, is not a correct definition of a fraction for it does not include simple fractions of groups nor any of the complex fractions.

So as to make the answer to this question more definite and specific the writer will limit the concepts to common fractions and decimals. The grades were by necessity limited to the sixth, seventh and eighth grades because as fractions and decimals are begun in the fifth grade in the Chicago schools, any study from tests would have to be made subsequent to that grade.

In working with the Chicago Arithmetic Survey Tests and revising them each year the writer has had occasion to examine a great many questions and answers in arithmetic. This has been necessary also in order to find a better grade placement for

some of the difficult topics. The topics of common fractions and decimals were chosen here because they have caused much discussion and interest since they have received a greater grade placement shift than some other topics barring long division. Furthermore the opinion is not yet crystallized as to which of these two concepts is the easier to learn.

In making up a test for concepts on fractions and decimals definitions, manipulations and processes were purposely avoided because they can be learned mechanically and would therefore give no information about concepts. A first attempt was made as shown on test I below. The first part of the test, questions 1 to 5 are based on problems and the second part, questions 6 to 10 are based on comparisons and relations. It was thought that some information on concepts could be obtained from the results of solutions of problems employing the use of fractions and decimals. An attempt was made to make the questions in the fraction section of the test correspond respectively to the questions in the decimal section of the test. This test was given to

TEST I

WHAT DO FRACTIONS AND DECIMALS MEAN?

(An Exercise in Understanding)

1. In the following numbers tell which are more than one: $\frac{3}{4}$, $\frac{7}{6}$, $1\frac{2}{3}$, $4\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{2}{3}$, $6\frac{1}{2}$, $\frac{9}{8}$, $2\frac{1}{4}$, $\frac{5}{8}$, $7\frac{7}{8}$, $\frac{7}{4}$.
2. In the following numbers tell which are more than one: .5, .75, .25, 1.5, .35, 4.3, 7.1, .8, 9.4, .1, 1.1, 10.

In the following sentences you are to select one of the three numbers in parenthesis that fits best.

1. Helen is in the 5th grade and is ($\frac{7}{8}$, $4\frac{1}{4}$, $10\frac{1}{2}$) years old.
2. Frank can jump ($\frac{3}{4}$, $4\frac{1}{4}$, $16\frac{1}{2}$) feet in a high jump.
3. James walked 4 blocks to school in (13, 5, 25) minutes.
4. Mrs. Thorne paid ($46\frac{1}{2}$¢, $3\frac{1}{4}$¢, 95¢) a pound for her turkey.
5. Jack ate ($\frac{5}{8}$, $\frac{1}{4}$, $\frac{7}{8}$) of a large pie for his dessert.
6. 24 is ($\frac{2}{3}$, $\frac{1}{2}$, $\frac{3}{8}$) of 36.
7. In the following fractions ($\frac{5}{8}$, $\frac{2}{3}$, $\frac{3}{4}$) is the smallest.
8. ($\frac{3}{4}$, $\frac{4}{4}$, $\frac{1}{2}$) is greater than $\frac{2}{3}$.
9. What is the next whole number smaller than $6\frac{2}{3}$?
10. What is the next whole number larger than $3\frac{1}{4}$?

In the following the answers are in decimals.

1. John is a 5th grade boy and weighs (70.5, 27.5, 119.5) pounds.
2. Fred threw a baseball (9.57, 95.7, 957) feet.
3. Mr. Jones drove his car (356, 35.6, 3.56) miles in an hour.
4. Henry bought a suit for ($3.750, $37.50, $375.0).
5. Mary ate (.1, .75, .9) of her big birthday cake at her party.
6. 36 is (.35, .8, .75) of 48?
7. In the following decimals (.8, .80, .08) is the smallest.
8. (.8, .69, .70) is more than .7.
9. What is the next whole number smaller than 8.6?
10. What is the next whole number greater than 5.65?

over 200 pupils in 7 grades in 6 different schools from 6A to 8B. It was found that the answers to the first five in each section were not reliable as giving any definite information on the concepts of either fractions or decimals because the problem situation gave the clue to the answer depending upon the pupil's familiarity with it. An example will make this clear. If you will turn to the test and notice question 4 in each section the results are given as nearly twice as many errors on no. 4 in the fraction section as those on no. 4 in the decimal section. But we cannot conclude from that that the fraction concept was so much harder than the decimal concept for the errors may have been due to the familiarity with the price of turkey compared to the price of a suit of clothes. The same holds true of all of the questions 1 to 5 in this test. This agrees well with other attempts at scaling problems. By changing one word in a problem we may step up or down the scale value of a problem by several points, depending upon the familiarity with that word on the part of the pupils taking the test. Problems, then, had to be excluded from our test. The last five questions on this test, however, gave a hint at some valuable information on fraction and decimal concepts.

Test II

Common Fractions and Decimals

In each of the following you are to underscore or encircle the number that makes the statement correct or that gives the correct answer. You will find several answers and you are to select the right one.

For example, in this statement the right answer is underscored. The correct answer to (2×3, 4−2, <u>2×2,</u> 2+3, 2×4) is 4.

1. $\frac{3}{4}$ equals (3, 6, 8, 2, 4) eighths.
2. Of the following fractions ($\frac{5}{8}$, $\frac{7}{8}$, $\frac{5}{6}$, $\frac{2}{3}$, $\frac{3}{4}$) is the largest.
3. Of the following fractions ($\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{5}$, $\frac{5}{8}$) is the smallest.
4. $\frac{4}{5}$ of 40 is (80, 32, 36, 24, 30).
5. 24 is ($\frac{2}{3}$, $\frac{1}{2}$, $\frac{5}{6}$, $\frac{4}{5}$, $\frac{3}{4}$) of 36.
6. 24 is $\frac{3}{4}$ of (28, 32, 16, 36, 40).
7. ($\frac{5}{6}$, $\frac{2}{3}$, $\frac{4}{5}$, $\frac{7}{8}$, $\frac{8}{9}$) is smaller than $\frac{3}{4}$.
8. ($\frac{3}{4}$, $\frac{4}{5}$, $\frac{1}{2}$, $\frac{2}{5}$, $\frac{3}{7}$) is greater than $\frac{2}{3}$.
9. What is the next whole number larger than $3\frac{1}{4}$?
10. What is the next whole number smaller than $6\frac{2}{3}$?

1. .6 equals (80, 90, 60, 6, 600) hundredths.
2. Of the following decimals (.5, .65, .8, .72, .7) is the largest.
3. Of the following decimals (.45, .35, .6, .9, .60) is the smallest.
4. .7 of 50 is (65, 35, 45, 25, 40).
5. 36 is (.5, .8, .75, .40, .6) of 48.
6. 30 is .3 of (50, 70, 90, 100, 60).
7. (.60, .45, .7, .65, .8) is smaller than .6.
8. (.8, .69, .70, .45, .60) is greater than .7.
9. What is the next whole number larger than 5.6?
10. What is the next whole number smaller than 8.6?

A new test had to be constructed from which definitions, manipulations, process work and problems had to be excluded. It was limited to meanings, comparisons and relations of various kinds of fractions and decimals. To give it proper scope it was extended to ten questions in each section and each question was extended to include five choices in the regulation multiple choice fashion. The questions as you will see were made strictly comparable in the two sections. This is Test II on the preceding page.

The test was given to 502 pupils in the 6th, 7th, and 8th grades in 15 Chicago elementary schools from representative

TABLE I. NUMBER AND PER CENT OF ERRORS IN COMMON FRACTIONS AND DECIMALS
Arranged by grades and test items

No.	N	1 F/D	2 F/D	3 F/D	4 F/D	5 F/D	6 F/D	7 F/D	8 F/D	9 F/D	10 F/D	Total F/D
Grade												
8A	150	44/86	124/112	110/124	65/47	71/92	83/113	56/102	82/45	72/75	87/103	792/899
%		29/57	83/75	73/83	43/31	47/61	55/75	37/67	55/30	48/50	58/67	52.4/59.5
8B	116	19/58	76/66	75/71	35/34	49/57	49/88	40/59	40/31	56/66	90/80	527/610
%		16/50	65/57	65/61	30/29	42/49	42/76	34/51	34/27	48/57	77/69	45.4/52.6
7	130	57/65	117/96	109/103	84/69	71/101	100/108	47/92	79/41	81/91	110/113	855/879
%		44/50	90/74	84/79	65/53	55/78	77/83	36/71	61/32	62/70	85/87	65.1/67.6
6	106	64/67	105/91	100/95	67/59	67/69	72/79	31/77	66/26	81/79	91/86	744/728
%		60/63	99/86	94/90	63/56	63/65	68/75	29/73	62/25	76/75	86/81	70.2/68.7
Total												
	502	184/276	423/366	394/393	251/209	258/319	304/388	174/330	267/143	290/311	378/382	2918/3116
%		36.7/55.0	84.3/72.8	78.4/78.2	50.0/40.1	55.7/63.5	60.5/77.2	34.7/65.7	53.2/28.5	57.7/61.9	74.8/76.0	58.1/62.0

In reading the above table we should say after grade 7 that there were 130 pupils in this grade and of these 117 missed question no. 2 in common fractions and 96 missed question no. 2 in decimals which in terms of % is 90 and 74 respectively.

Under the total of ten questions these 130 pupils missed 855 in common fractions and 879 in decimals which in % is 65.1 and 67.6 respectively.

districts. The results of this test are shown in tables I and II.

In summarizing the results it may be said that, assuming that this was a fair test for concepts in fractions and decimals, on the whole the fraction and decimal concept is only about 40% learned or developed throughout the grades 5 to 8. In grade 6 it is about 30% developed, in grade 7 about 33% developed, in grade 8 about 50% developed.

Some may say that the test was too difficult, but that can hardly be maintained when the simple questions are examined. When 74% of the pupils from 6th, 7th and 8th grades do not know what the next smaller whole number to $6\frac{2}{3}$ is, can we say that they have a concept of the meaning of fractions? Similar questions could be asked with reference to the other questions. Let it be added that there are other questions more difficult that could be asked about fractions and decimals that were left out here. An example of one of these more difficult questions would be, What effect on the value of a proper fraction does adding the same number to both numerator and denominator

TABLE II. NUMBER AND PER CENT OF ERRORS ON COMMON FRACTIONS AND DECIMALS

Arranged by grades and M.A. groups of pupils

M.A.	*N*	8A Errors *F/D*	*N*	8B Errors *F/D*	*N*	7th Gr. Errors *F/D*	*N*	6th Gr. Errors *F/D*	*N*	Total Errors *F/D*	Total % Error *F/D*
17.0	3	6/ 4							3	6/ 4	20.0/13.3
16.5	1	8/ 5	1	3/ 2	2	7/ 6			4	18/ 13	45.0/33.3
16.0	8	27/ 41							8	27/ 41	33.7/51.2
15.5	7	22/ 24	10	20/ 35					17	42/ 59	24.4/34.7
15.0	6	23/ 34	10	51/ 62	1	3/ 6	1	6/ 3	18	83/ 105	46.0/58.4
14.5	19	79/ 88	14	15/ 65	11	69/ 66	2	16/ 12	46	219/ 231	47.6/50.4
14.0	11	64/ 64	23	95/109	9	38/ 43	7	38/ 46	50	235/ 262	47.0/52.5
13.5	23	114/152	20	107/108	20	116/125	7	56/ 58	70	393/ 443	56.1/63.3
13.0	14	79/ 85	7	43/ 41	15	93/100	11	75/ 57	47	290/ 283	61.7/60.3
12.5	18	114/124	10	41/ 50	28	188/178	10	64/ 57	66	405/ 409	61.4/62.0
12.0	12	78/ 83	8	41/ 51	18	124/140	17	127/126	55	370/ 400	67.2/72.7
11.5	10	64/ 71	9	57/ 66	12	104/108	17	115/122	48	240/ 367	70.8/76.5
11.0	10	61/ 75	2	55/ 7	4	33/ 27	17	127/116	33	226/ 225	68.5/68.3
10.5	3	18/ 24	1	3/ 4	5	39/ 38	9	60/ 66	18	120/ 132	66.7/73.3
10.0	2	13/ 11	1	6/ 10	1	9/ 9	7	52/ 58	11	80/ 88	73.5/80.0
9.5	2	14/ 7			4	34/ 33	1	8/ 7	7	56/ 47	80.0/67.1
9.0											
8.5	1	8/ 7							1	8/ 7	80.0/70.0
Total	150	792/899	116	527/610	130	855/879	106	744/728	502	2918/3116	58.1/62.0
%		54.4/59.5		45.4/52.6		65.1/67.6		70.2/68.1		58.1/62.0	

In reading the above table after the 13.5 M.A. group there were 20 in the 8B grade who missed 107 and 108 respectively of the 200 questions in each section. Of the total of 70 in this group 56.1% and 63.3% of the questions were missed respectively.

have? Is the effect the same on an improper fraction? Hence an answer to all the questions in the test would not indicate a complete mastery of the fraction or decimal concept.

Let us turn to a brighter picture. It is seen from a study of table II when the degree of learning is compared with the mental ages as we go up from the mental age of 8.5 to 17.5. As we go up in the scale of ages the errors are decreased from 80% in fractions and 70% in decimals at the $8\frac{1}{2}$ M.A. level to 20% in fractions and 13% in decimals at the $17\frac{1}{2}$ M.A. level. This throws a ray of hope on the scene, in that as the pupils grow older mentally they do develop in the mastery of the fraction and the decimal concepts. Thus a partial answer at least to our question in the title is given. Whether this development is due to teaching or an increase in maturity is another question. It is, no doubt, due to both. From the results of table II the coefficient of correlation by the method of ranks was computed between mental ages and decrease in errors and found to be as high as .97 for fractions and .91 for decimals. When from table I the coefficient of correlation was computed between ascendancy in grades and decrease in errors it was .80. This would seem to indicate that M.A. is a stronger factor than school grade in conditioning the learning of fractions and decimals. Too much reliance cannot be placed on this, however, because of too few cases and grades to establish sufficient sampling.

Another interesting feature stands out as a result of this experiment, both from Test I and Test II. In the last five questions of Test I which were very similar to the questions in Test II, the number of errors in the common fraction section were greater than the number of errors in the decimal section and the difference was greater in the 6th grade than in the 8th grade. The numbers were 466 or 44% for fractions and 398 or 38% for decimals. Likewise in Test II the errors in fractions outnumber those in decimals in the 6th grade but as we go up to the 8th grade the reverse is true. It is difficult on the basis of this test alone to account for the fact that decimals are better learned than common fractions in the 6th grade and not so in the 8th grade. The fact that, after a year's acquaintance and study of both decimals and fractions, the pupils have a better knowledge of decimals than fractions and then a year or two later the reverse is true calls for an explanation. The writer's explanation is this. Most teachers, since to them, fractions were taught earlier than decimals, emphasize the fractions more than deci-

mals, and the fact that the number of pages in our arithmetics devoted to common fractions is about three times as great as the number devoted to decimals, would tend to give more practice and teaching to the common fraction.

To further check on this assumption, however, the writer carefully examined the doctor's thesis by A. E. Robinson on "Professional Education of Teachers of Arithmetic" A large part of this dissertation is made up of questions to teachers. From an examination of 18,976 test papers given in the period 1929 to 1931 to members of Teachers Colleges and Normal Schools in and around New York City, 65 questions dealt with arithmetic operations. On those dealing with common fractions the average per cent of failure was 22.28% and on those dealing with decimals the average per cent of failure was 20.45%.

In a 60-question test dealing with principles underlying arithmetical operations given to 322 graduates of professional schools mostly from 3-year normal schools, most of them having had experience in teaching more than a year, the per cent of failure in common fractions was 84.76% and no questions dealing with decimal principles were found. No conclusion can be drawn from this test unless it be that decimals were considered easy and therefore not tested.

When 42 teachers were interviewed in conferences on subject matter difficulties by means of 37 questions, the average per cent of failure on the common fraction questions was 83.8% while on the decimal questions it was 73.1%.

When 79 questions on method of teaching mathematics were given, the average per cent of failure on the fractions was 39.5% and on the decimals, 36%.

In another chapter Robinson gives the results of difficulties encountered by teachers and principals as revealed by requests for assistance. Out of 100 different requests occurring 595 times there were 16 different requests on fractions occurring 66 times and only 10 on decimals occurring 55 times.

In all of the above instances cited by Dr. Robinson and occurring in different situations there was a greater difficulty with common fractions than with decimals and this was with teachers and adults.

From other investigations also it has been quite generally accepted that decimals are easier than common fractions both as to time in initial learning and as to time and accuracy in performance after learning.

In light of the very low achievement in both common fractions and decimals as revealed by the tests in this experiment, the writer seriously doubts the advisability and even the possibility of teaching both common fractions and decimals to any degree of proficiency in the elementary school.

In conclusion the writer wishes to make the following observations and recommendations.

Whereas, both common fractions and decimals cannot be taught to any degree of satisfaction commensurate with the time and energy spent upon them and

Whereas, decimals can be learned in less time than common fractions, and

Whereas, mechanics, engineering and aviation, not to mention many other common activities are using decimals more and more to the exclusion of the common fraction, and

Whereas, the concept for decimals is but an extension of the concept of whole numbers in the principle of place value, and

Whereas, the space in our arithmetics devoted to common fractions now is about three times the space devoted to decimals, and

Whereas, the pupils in our 5th and 6th grades would enjoy their arithmetic more if they understood and mastered more of the material covered, and

Whereas, teachers would have time to do some real teaching of concepts instead of forever having to hurry to get through with the work called for in the course of study,

Therefore, be it recommended to educators and curriculum makers everywhere, that the decimals be taught in the fifth grade immediately following and linked up to United States money in the fourth grade, thereby continuing and strengthening the whole number concept at the same time that the decimals were developed, and that operations with common fractions be limited to halves, fourths and eighths for mastery.

OCCUPATIONAL INDEX

The 1943 *Occupational Index*, containing 375 annotated references on 74 military occupations and 234 civilian occupations, is now available in cloth binding at $6.50 from Occupational Index, Inc., New York University, New York 3, N. Y.

Among the new and unusual occupations included are, Airline Passenger Agent, Aviation Dietitian, Cartography, Industrial Nursing, Junior Weather Observer, Moss Picking, Naturopath, Physiotherapy, Rehabilitation, and Salvaging.

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago, Illinois

64. Finding Square Roots. *First Year Mathematics* by Evans and Marsh, published in 1916, is the oldest text I have containing what I call the *Guess* and *Divide* method for finding square roots. The method also appeared in *First Year Algebra* by Milne and Downey, published in 1924. I included the method in my *Geometry* (1929) and in the *Survey* (1935), but the method has been neglected by most books. Hence I welcome, with enthusiasm, the recommendation of the army that this method be taught to all. And the attention of physics teachers should be called to the method since few of them have heard of it. Further, I hope that all supervisors of mathematics will plan to have the method replace the old one in elementary schools.

For example, to find the square root of 1944, we begin by estimating that the root is about 45. Next, we must resist the temptation to square 45 to see how good the estimate is. Instead we divide 1944 by 45. If the quotient is the same as the divisor then we have found the square root. Since this seldom happens, we continue dividing until the quotient contains just one more figure than the divisor. $1944 \div 45 = 43.2$.

Next, average the quotient and divisor. $\frac{1}{2}(45+43.2)=44.1$. Then repeat the work, using 44.1 as the next divisor.

$$1944 \div 44.1 = 44.08 \qquad \tfrac{1}{2}(44.1+44.08)=44.09$$
$$1944 \div 44.09 = 44.092 \qquad \tfrac{1}{2}(44.09+44.092)=44.091$$

We can stop at any stage depending on how many figures are wanted in the root.

A class can learn the method in ten minutes since the rules are simple: Guess, Divide, Average. When starting the method I send ten pupils to the board and let each make his own first estimate. The class is always surprised when all the pupils reach the same result despite the variation in the first guess. But some pupils reach the result sooner than others, and so we have good motivation for learning how to make a good estimate. This can be done in the following steps:

1. Learn the squares of the powers of 10.
2. Learn the rule for squaring a number ending in 5: drop the 5; multiply what remains by the next higher integer; annex 25.

3. Learn how many figures to expect in the square root.
4. For numbers less than 1, learn:

$$\sqrt{a}=(1/10)\sqrt{100a}=(1/100)\sqrt{10{,}000a}$$

As an extra-credit problem for bright pupils I assign: Explain how the method can be adapted to finding cube roots.

65. Daily Reviews in Algebra. In the October NOTES I mentioned that each day's work in algebra and geometry might well begin with a short review. Teachers have written me that such reviews are possible in geometry but not in algebra because, in the latter, there are fewer general principles and definitions to review. But the review I have in mind can also consist in having the pupil state some of the steps in a problem, as in the following examples:

1. On page a, problem b (followed by a pause to give the pupil time to find the page and problem), how do you begin? The pupils answers: Write j = John's age, and $j+5$ = Henry's age. This may be all that is done with this problem when reviewing, and we proceed to the next one.

2. Page c, problem d. How do you begin it? Ans. Multiply each term of the equation by 18 getting $2x-3x+15=6$.

3. Page e, proglem f. What idea is used in forming the equation? Ans. John's distance equals Henry's distance.

4. Page g, problem h. Do the multiplying. The equation in the text is $2(3x-4)-(x-2)=5$ and the pupil answers: $6x-8-x+2=5$. The problem is left unfinished since we are merely reviewing the treatment of parentheses.

5. Page i, problem j. What is the equation? Ans. Cost plus profit equals selling price, or $c+.10c=220$.

6. Page k, problem l. Do the multiplying. The problem reads $5y(y^2-6y+7)$. Time is saved by not having the pupil read the quantities aloud. He merely answers $15y^3-30y^2+35y$.

7. Page m, problem n. What idea must be kept in mind? Ans. What part of the job each man can do in one day.

8. Page o, problem p. If you have no idea how to solve this problem, how can you get an inspiration? Ans. Try some specific numbers for the general numbers, like saying 5 books cost 10 cents instead of b books cost c cents.

9. Page q, problem r. Do the multiplying. The problem is: $(x+3)(y-5)$ and the pupil says only: $xy-5x+3y-15$.

10. Page s, problem t. What will be the denominator when the fractions are added? Ans. $x(x+y)$.

11. Page u, problem v. What must you do first? Ans. Transpose the bx, so that you have $ax+bx=c$.

12. Page w, problem x. Why is it wrong to cross out the x^2 in the numerator and denominator? Ans. That's not dividing the numerator and denominator by x^2.

13. Page y, problem z. What is another way of writing $\sqrt{\frac{2}{3}}$? and the pupil answers $\frac{1}{3}\sqrt{6}$.

Naturally all these questions are not used in one day; they merely indicate possibilities. The number of the page should be stated first and followed by a pause so that the pupil has time to find the page. Then the problem number is stated. In the course of a month the same question may be asked several times. This work helps to reduce certain types of errors such as forgetting the denominator when adding fractions, forgetting a monomial factor, forgetting how to handle fractions preceded by a minus sign, forgetting that the square root of a sum is not the sum of the square roots, forgetting how to cancel, etc.

I once heard a doctor explain why we do not remember anything about the first two years of our lives. He said that we can best remember events that we have talked about, and few children talk before they are two years old. The lesson for teachers is evident. Teachers should talk less and make pupils talk more. A pupil who has added fifty fractions on paper without forgetting the denominator is still more likely to forget the denominator two years later than the pupil who has recited fifty denominators aloud in the class at intervals spread over two months.

66. Lessons from the Iowa Testing Program. Reports like that from Iowa State College in the *Mathematics Teacher*. Nov. 1943, show what is actually taught in school. If a similar test can be given in 1947 or 1948 we shall have some good evidence on the influence of the war. I venture the prediction that the better pupils are now doing better work than usually and the poorer pupils are doing even poorer work.

Some of the questions on the test are of doubtful value. For example, a pupil may have had few occasions to use the words *highest common factor* and still may be able to do correctly any problem involving the *use* of a highest common factor; that is, he can *use* the concept without knowing its technical *name*. Likewise, a pupil may know that $a(b+c)=ab+ac$ without knowing the *name* of the law. To him it might as well be called the associative law since he is associating the number a with both b

and c. Also, a pupil might be able to solve the set $y=9x^2$ and $y=3x$ but not know what is wanted when told to "solve for simultaneous values."

Errors that arise because a pupil does not know that $2x^3$ is not $(2x)^3$, and many other errors, could be eliminated by frequent short oral reviews as suggested in section 65. Incidentally, an exponent is like a workman with very short arms; he can reach only as far as the *nearest* number. The 3 in $2x^3$ cannot reach the number 2; it can work on or influence only the x.

Both algebra and geometry classes neglect general problems, as shown by the poor result (only 1% right) on the problem:

The altitude of an equilateral triangle is a. What is the length of the side?

When studying the Pythagorean Theorem a geometry class may well spend a week on square roots (using the method discussed in section 64) and on radicals. The work should involve:

$$\sqrt{120}=2\sqrt{30} \qquad \sqrt{\tfrac{2}{3}}=\tfrac{1}{3}\sqrt{6} \qquad \frac{1}{\sqrt{3}}=\tfrac{1}{3}\sqrt{3}$$
$$\sqrt{20}+\sqrt{45}=? \qquad \sqrt{20+45}=?$$

and similar changes with general expressions like

$$\sqrt{3a^2} \qquad \sqrt{a^2+4a^2} \qquad \sqrt{a^2+b^2}$$

and solving equations like

$$x^2+a^2=(2a)^2 \qquad x^2+(\tfrac{1}{2}a)^2=a^2$$

Later, when areas are studied, the class should find the area of an equilateral triangle in terms of a side, in terms of an altitude, in terms of the radius of the inscribed circle, etc.

Only 16% of the pupils solved the problem:

One man can do a piece of work in 9 days; another can do the same work in 6 days. How long will it take both men to do the work if they work together?

This type I teach in every class, whether it is general mathematics, algebra, geometry, trigonometry, or solid geometry. It could be taught in the seventh grade when pupils learn to work with fractions. Together the men do $1/9+1/6$ or $5/18$ of the work in one day. Hence $18/18 \div 5/18$ is the number of days needed to do $18/18$ of the work. To do $3/4$ of the work they need $3/4 \div 5/18$ days. If the slow worker has a day 2 start, then he has finished $2/9$ of the work, leaving $7/9$ to be done; and they can finish in $7/9 \div 5/18$ days. In this connection see also the NOTES for Jan. 1943.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

ONE HUNDRED FIFTY-SIXTH MEETING

MASSACHUSETTS COLLEGE OF PHARMACY
Boston, Massachusetts
Saturday, December 4, 1943

▼

MORNING PROGRAM

A joint session with
The New England Biological Association
and
The New England Association of Chemistry Teachers

Dr. Eldin C. Lynn, of the Massachusetts College of Pharmacy, will act as chairman of the meeting.

9:50 Address: Effect of Tropical Diseases on Civilians as a Result of the War: Dr. V. A. Getting, State Committee of Public Health.

10:40 Address: Science Teaching Today and Tomorrow: N. Henry Black, Assistant Professor of Physics, Harvard University.

11:30 Address: Penicellin: Dr. C. L. Keefer, Director of Evans Memorial.

12:30 Luncheon, at the College of Pharmacy.

AFTERNOON PROGRAM

The afternoon program will be held at Boston Police Headquarters, at the corner of Stuart and Clarendon Streets.

2:00 Business Meeting.

2:15 Address: Scientific Crime Detection: Deputy Superintendent James Hinchey.

After the address, there will be an opportunity to inspect the various "crime laboratories" at the Boston Police Headquarters. These include the ballistics laboratory, the identification laboratory, the radio broadcasting room with its teletype and short wave equipment, etc. This is a rare opportunity to see the inner workings of a well-equipped city police department.

Officers:

President: Louis R. Welch, English High School, Boston, Mass.
Vice-President: George H. Blackwell, Groton School, Groton, Mass.
Secretary: Carl W. Staples, High School, Chelsea, Mass.
Treasurer: Albert R. Clish, Belmont High School, Belmont, Mass.

BUSINESS MEETING

The following were elected to active membership: F. Eldred Hodge, Colby Junior College, New London, New Hampshire. Winston B. Keck, Shrewsbury High School, Shrewsbury, Massachusetts.

EFFECT OF TROPICAL DISEASES ON CIVILIANS AS A RESULT OF THE WAR

(Abstract of address by Dr. V. A. Getting)

Since December seventh, 1941, America has been conscious of war, but public health officials have been concerned for many years. War recognizes political boundaries, but bacteria do not. Wars are always attended by famine, disease, or pestilence. Diseases may often determine their outcome. Armies have always been reservoirs of infection, usually, however, restricted to zones of military activity, and rarely spreading. Among the diseases have been typhus, smallpox, typhoid, malaria, dysentery, and bubonic plague, to which have lately been added influenza and lung infections. Crowding of people in concentration camps, bomb shelters, etc., with lack of sanitation and personal hygiene, together with concentration movements of armies, *and especially refugees*, have tended to spread these diseases among civilian populations.

In the past it has been said that more were killed by germs than by bullets. In 1904, in the Russo-Japanese War, there were more war than disease casualties. The same was true in 1917, but after the war, diseases like typhus and relapsing fever were prevalent in Eastern Europe and Asia. Malaria, victor in Macedonia, returned with soldiers to Central Europe. This country escaped importation of these diseases because her troops were not fighting in infested areas.

In this war, however, American soldiers are exposed to potential infection, which will reach its peak after the war. Large numbers of susceptible people are subjected to exposure to dysentery, typhoid, para-typhoid, and added to these now are many tropical diseases. Refugees constitute a danger as sources of latent infections, and as carriers.

We realize now that tropical lands are their usual abode, but not their geographical limitation. Yellow fever is an example of a disease of a special group, more prevalent in the tropics, caused by protozoans and metazoans, and limited by prevalence of host carriers, etc. Lack of hygiene causes their spread.

Malaria is indigenous deep into the temperate zones, where it is relatively benign, but the tropical plasmodium is more serious. Outbreaks of bubonic plague have appeared on the coasts, and have spread from the west, carried by rodents.

Leprosy has at times appeared in New England. Other diseases have at times appeared in areas out of their usual environment, as cholera, Rocky Mountain spotted fever, and amoebic and bacillary dysentery. Sanitary conditions are a limiting factor; climate is not valid as such. Diseases may be transferred when the spread of war creates new and artificial conditions favorable to the spread of tropical diseases.

In peacetime, protection is a problem; in war, almost impossible. War reduces measures of protection, and entails increased exposure. There are vaccines against typhoid, paratyphoid, and smallpox, but none that are certain for cholera, typhus, etc.

Armies form mobile reservoirs of infection, active and latent. Serious malnutrition forms a fertile soil for diseases to spread. There are six ways of increased spreading:

1. Aviation increase brings infected individuals to new areas within the incubation period of many diseases.
2. Importation of necessary animal reservoirs, the rat, for example, makes conditions favorable for plague.
3. Importation of necessary infector or carrier by airplane. (*Anopheles gambii* for example.)
4. Potential adaptation of agent to transmission by a species other than the usual one. In some parts of Africa yellow fever is carried by certain bugs, in other parts, by mosquitoes.
5. New reservoir host adaptations. Some diseases adopt a variety of animal hosts. (Examples, bubonic plague, and tularemia.)
6. Importation of new strains of disease, as malignant diphtheria of a new type.

Members of armies and navies will transmit diseases, and after the war, migrations will spread latent endemic tropical diseases, as has been shown by ample precedents. If operative, this will alter present conditions.

In Massachusetts we are not so much concerned in Europe, Asia, and Africa. Their diseases are not likely to become indigenous in New England Latent forms are only of rare occurrence here. Some tropical diseases, as intestinal typhoid, etc., are endemic in Massachusetts, but there is little danger from this if proper disposal of sewage and washing of hands is practiced.

Immigrants used to be infested with lice, but this is rare now-a-days. If the rat population should increase, and sanitation were broken down, there would be danger if lice and carrying organisms increased.

Dengue and yellow fever are not likely to be prevalent in Massachusetts *Anopheles egypti* cannot survive a New England winter, and would have to be reintroduced.

Malaria is endemic in New England. There have been three epidemic waves since 1800–1810. Now cases are rare. There have been, in the past 14 years, eleven cases from mosquito bite in Massachusetts. Each new house and farm built has decreased the breeding places of the mosquitoes. Carriers may act as foci of local endemics. These are followed up by the State Health Department to prevent spreading. Mosquito control measures are ready if needed.

The evening before the meeting word came that Professor Black was ill and could not attend. Mr. Welch, unable to get a substitute speaker filled the gap by speaking on:

STRATOSPHERE FLIGHTS

(Abstract of talk on Stratosphere Flights)

Three distinct groups have had a part in stratosphere flights, the professional dare-devils, the military fliers, and the scientists. Each has had a

separate objective, but all have contributed much to our knowledge of the stratosphere. Each has drawn freely on the experiences of its predecessors, so that improvement in technique has resulted.

The flights began with balloon ascents at state fairs and similar gatherings, and these reached their zenith in 1875, when a balloon rose to a height of $5\frac{1}{2}$ miles over Paris. St. Pierre alone survived the flight, his two companions having died from lack of oxygen. Conditions which must be met for further study were learned from this flight.

Each investigator had to learn the hard way. In the World War it was found, that, in dog-fights, the plane on top had a decided advantage, and this led to experiments for attaining higher altitudes. The army-air corps tried experiments under combat conditions on the Pacific Coast.

At a height of 5 miles oxygen had to be carried, and above 3 miles a supercharger was needed. Still, planes with open cock-pits were used. In one of these flights Schraeder's mask went wrong and he removed it. Becoming unconscious, he went into a spiral dive, but regained consciousness in time to get partial control of the plane before it reached the ground.This accident led to experiments with planes having closed cockpits. Lt. Macready trained himself for high flights, and tested one of the first of these planes. It had an airtight covering with 2 large circular plate-glass windows, with an intake valve back of the propeller, and a release valve. It was hoped that normal pressure would be maintained by the blast of air. Unfortunately the release valve failed at $1\frac{1}{2}$ miles and the pilot was squeezed by air-pressure. He was able to fight off the effects and bring the plane to the field, where a companion broke one of the windows, relieving the pressure, and saved him.

In the 1920's the military and naval experiments stopped. The study was taken up by research scientists. These were the antithesis of the dare-devil. They had theories which they wished to prove by actual experiment. Cosmic ray research gave impetus to the work during this time, as scientists were trying to find out the source of these rays, whether from the sun,or from the center of the earth.

Professor Picard favored the sun theory. He made tests on mountains and in deep lakes, but was not satisfied. He wished experiments at a higher level. There were three questions to answer before making a stratosphere flight:

1. How high could instruments be taken?
2. How get them there?
3. How live at that altitude?

At ten miles, .9 of the atmosphere would be below the flier. This made the first question relatively easy to answer.

To reach the stratosphere 3 means were considered, airplane, rocket-ship, and balloon. Fliers had proved that 6 or 7 miles was the approximate limit for heavier than air craft. This eliminated the plane. There was much scientific and pseudoscientific information on rocket-ships but no ships were available.

In the balloon it was necessary only partially to inflate the bag because of expansion. This craft was more troublesome, but Hall had discovered a process for aluminum, and experiments on welding this metal had been carried out, so Picard had constructed a gondola, a sphere with walls .1 of an inch thick. The greatest difficulty was temperature. No heating device could be used as all the oxygen was needed for breathing. So one side of the sphere was painted black. Two electrically driven propellers were attached outside and if the temperature got too cold, by throwing a switch the propellers were supposed to turn the craft.

In May, Picard left Augsburg, Bavaria, chosen because it was farthest from large bodies of water. Studies had shown that flights should start about 4 A.M., as at that time there were fewer down drafts. The balloon rose 10 feet and settled down again. In September a second flight was attempted. An electrostatic sounding device was to be used, and in attempting to put it in place after the start, the threads were stripped and it was impossible to insert it in the socket provided. This made it necessary to plug the pipe to prevent the air escaping from the gondola. This was done with oakum, and the rest of the flight proceeded easily and without incident. Rising at 20 miles per hour the pressure height was reached in 28 minutes. At sunrise however, the temperature inside rose to 104° while it was $-70°$ outside. The switch was thrown but the propeller blade would not bite as the pressure was too low, and nothing happened. An obvious mistake. There was danger of the rubber cement used to seal the port holes melting. Picard tried to remove some gas, but in his excitement the cord broke. He said there was nothing to do but wait so they sat in the gondola and waited. The afternoon cooling made the gas contract and the balloon began to descend slowly. By six o'clock it was at a height of $7\frac{1}{2}$ miles. By 8 or 9 o'clock, it was 1 to 2 miles above ground. As it was probable they would land with a bounce, each person had provided himself with two large sewing baskets, well-padded, one to put on the head and one to sit on. They landed easily and in the morning made their way to the nearest village.

Picard made several more flights, each time taking a different companion with him. On the last flight his wife accompanied him. The flights were a success from the point of view of cosmic rays and aviation. It was concluded that Europe was not the best place for the experiments because of the nearness of large bodies of water, so the experiments were transferred to America. In 1933 a flight was attempted at 10 o'clock at night, but down drafts tossed the balloon into the Chicago stock-yards. The next year Stephens made another attempt from the stratosphere bowl in the Black Hills. Helium was used. The upper part of the sphere was painted black and the lower half aluminum color. Forty bags of lead dust were hung on the outside, each containing a dynamite cap and having wires connected with switches inside the gondola. By releasing some of these at the start they prevented a crash with a pine tree on the edge of the bowl, and made a successful flight.

PENICELLIN

(Abstract of Address by Dr. C. L. Keefer)

When requested to review the development and history of penicellin, a word as to its pronunciation is timely. The British call it pen-*i'*-cell-in, but here it is called *pen'*-i-*cell'*-in.

An investigator in St. Mary's Hospital in London in 1929 was studying *Staphylococcus pyogenes aureus* and variations in its colony structure and forms occurring in artificial media. In opening the petrie dishes from time to time, some cultures became contaminated. He decided not to throw them away, but to follow them and observe the changes that took place. One of the dishes was found to contain a mold. As this increased the staphylococcus colony became reduced in size and changed its characteristics. This aroused his curiosity and he isolated the mold and made a pure culture of it. He grew it for ten days in a liquid medium, filtered it, and tested the clear broth against a wide variety of organisms. It was found to contain a substance which hindered the growth of many kinds of organisms. It had great specificity, affecting mostly gram-positive types, but gonococcus and meningococcus were exceptions.

The substance was found largely non-toxic in animals. White corpuscles remained active in 1:600 concentration. It had no harmful effects on the skin.

It was suggested that it might have a use in treating infections but, due to its instability, penicellin was difficult to manufacture on a large scale. The investigator had a notion it might hinder the growth of gram-negative organisms, so this was tested on the influenza bacillus.

Nothing developed on a large scale until 1939, when it became apparent that sulfanilamide is not effective in some cases and in wound infections. Staphylococcus infections are present in most wounds. Streptococcus infections could be controlled, but usually they were mixed infections.

Reinvestigation was made to find a medium to support the growth of penicellin and yield a large growth. This was followed by extraction and chemical treatment, usually with amyl acetate or chloroform. The sodium salt was made. This was injected into the muscles or veins without any bad reaction. It was, however, unstable, and there were losses in extraction so that relatively slow progress was made in obtaining large amounts.

Some manufacturers found it lost its entire potency in 20 minutes, and 3 minutes were needed for extraction. The urge to produce was great, and in spite of difficulties many problems were solved, and an increasingamount became available. Due to shortage of man-power in England it was hard to produce enough for their use and that of others.

A professor came here from England two years ago, and addressed the Society of Medical Research, interested the society, and several manufacturing chemists were induced to undertake the program of research on quantity production. In 6 or 8 months small amounts were available for clinical tests.

The substance is a brown powder, and extremely hygroscopic. Once hydrated it is extremely unstable unless kept at ice-box temperature.

Sodium, ammonium, magnesium and calcium salts were tested. The magnesium salts were found toxic to animals, so calcium and sodium salts were used. In this country most of the work has been done with the sodium salt.

The substance is assayed according to Oxford units. This is a clumsy method, but the best at present. Originally this was the amount, which, added to 70 cc. of broth, completely prohibits the growth of staphylococcus of standard growth. Better standards will develop such as weight, or the milligram perhaps.

Most of the material obtained is relatively impure, because it would contain 2000 units per milligram if pure. That used is 200 to 300 units per milligram, but even this is very active and prohibits growth in the test-tube and in man.

A new substance must have much preliminary study. Chronic toxicity experiments on animals must be made and it must be ascertained what organisms are affected unfavorably. The optimum concentration must be found first in animals and then in man, before it can safely be used.

Although found active against a wide variety of organisms the latter vary a great deal in sensitivity. Staphylococcus is most resistant, and more material is necessary than against gonococcus.

It is inactive when given by mouth, as it is destroyed by the gastric hydrochloric acid, and is absorbed so irregularly in the intestine as to be impractical.

When injected in the muscles or veins, it is absorbed and very active. It is absorbed and rapidly excreted by the kidneys and to some extent in the bile. This is important because, if sufficient concentration is to be maintained in the blood and tissues, there must be a constant level day and night. Continuous infusion in the veins or repeated injection into the muscles is necessary.

The question of how selected group patients should be chosen arose. Information was first obtained on infections in horses, etc. Then a selected group of infections occurring in wounds, gas gangrene, gonorrhea, pneumococcus, etc. were studied.

When staphylococcus invaded the blood stream, 85–90% were fatal, leaving 10 to 15 chances of surviving. Sulfanilamide reduced this 85–90% to about 60–70%. Penicellin reduced it to 35%. This was not what was wanted. In analyzing the failures, inadequate amounts (where adequate amounts were not available) explained many of the failures, since all cases were included in the data. If patients were in all cases adequately treated, there is reason to suppose the failures would be reduced to 10 or 15%.

Wound infections in army and civilian hospitals were studied. Gun-shot wounds offered many problems. The fractures were not clean, but shattered into 10 or 15 pieces. In such cases the bone dies. Infection follows removal of the foreign body. Results, however, have been encouraging. In

the last war, of those who survived the first shock of the wound, 20% died from infection; in this war, less than 2%.

As regards diseases, sulfa-resisting gonorrhea should be wiped out in the future by penicellin. Certain forms of pneumonia are favorably affected, but virous pneumonia is not influenced. Neither are malaria, typhoid, dysentery, influenza, or heart valve infections.

Toxic effects are practically non-existent. It is innocuous, and does not damage tissues.

Fighting one organism by means of the products of another is not new, but has been known for a number of years. Pasteur made use of the idea to help the wine-growers.

Many molds may contain useful substances, but most of them secrete protoplasmic poisons. It may be possible to remove the toxic substance and retain the antibacterial substance. This may be the beginning of an era in which we may have a large number of these anti-bacterial agents, and it may be hoped that some time we may have a shelf on which we may put enough of these to control most kinds of infections.

VISIT TO THE CRIME LABORATORIES OF THE BOSTON POLICE HEADQUARTERS

Through the courtesy of Deputy Superintendent James Hinchey, members of the Association were given the privilege of visiting the well equipped laboratories of the Boston Police Headquarters.

These laboratories may be divided roughly into the following sections:

1. Identification Laboratories.
2. Ballistics Laboratories and Museum.
3. Photographic and X-ray Laboratories.
4. Teletype and Radio Room.
5. Radio Panel Room and Dictaphones.
6. Radio Repair and Testing Laboratory.

The identification section consists first of all of a large room with a kind of stage equipped with strong lights at the front. In use the stage is lighted and the rest dark. Hold-up suspects are lined up with other people on the stage, and detectives and victims and witnesses of hold-ups, view the line-up from the dark part of the room to see if the victims or witnesses recognize anyone on the stage as the perpetrator of the crime. Often he is recognized, and often again he is not. Sometimes, even if not recognized, other evidence may help the police in getting a confession from the culprit. The work of the police has, however, at least two sides, namely apprehending criminals, and preventing crimes in the first place.

Those brought in for felonies are fingerprinted and photographed in another room. There are also in this section some of the old measuring devices for the Bertillon system, although these have been reduced to secondary importance by the finger-printing system. Opening on this room is the classification and filing room where over 200,000 sets of finger-prints are filed away.

The ballistics laboratory is very interesting. It is a combination of laboratory and museum. Here on wall panels and in cases reaching from ceiling to floor are collections of thousands of small fire-arms and other weapons and implements taken from criminals or persons carrying them illegally, and kept here for purposes of comparison and record. They in-

clude revolvers, rifles, sawed-off shot-guns, air rifles, "sand-bags," and clubs of various kinds, time-bomb systems, grenades, knives, burglars' tools, and numerous others.

There are exhibits of "dope" outfits taken in raids, counterfeit money, photographs of special cases, tear gas guns and shells, and series of cloth samples showing the effect of bullet and powder on the cloth when discharged from various types of fire-arms at different distances. There are samples of different kinds of glass, and numerous files of many other materials of importance in the tracing of criminals.

The laboratory side of this section includes microscopes of different types including a large comparator microscope for comparing bullets and other objects, equipment for chemical tests on inks, blood, counterfeit money, and for the examination and photographing of handwriting specimens, etc. One of the laboratory workers showed us the method of examining and comparing bullets. He fired a revolver shot into a large fibre basket filled with tightly packed cotton. The bullet penetrated one or two feet into the cotton and was recovered and examined. The sides were scored with longitudinal grooves made by the barrel of the revolver. In an actual test, where the suspected weapon has been recovered, and a bullet has been found in the body of the victim or nearby, the weapon is taken to the laboratory, discharged as described above and the bullet compared with the one found at the scene of the crime. Each fire-arm leaves its "finger-print" on the bullet in the form of characteristic grooves. These may also be compared by placing them on a comparator-microscope set-up in another laboratory. The two bullets revolve in the apparatus and an enlarged photograph of the entire circumference of the bullet is made, one above the other. If the grooves coincide, the bullet was fired from the same weapon.

In the same laboratory is a large vault-room in which are stored supplies of ammunition and fire-arms of various types, as rifles, revolvers, shot-guns, tommy-guns, tear-gas guns, etc., for the use of the police. The vault also contains targets and space for testing the working of fire-arms.

The photographic section has apparatus for photographing places and persons, and photomicrographic apparatus for photographing bullets, and other small objects, as well as apparatus for enlarging photos of handwriting, fingerprints, and similar data.

It has a dark-room and laboratory where pictures are developed and other tests carried out. There is also X-ray and ultraviolet light equipment for photographic work, and detection of counterfeits, obliterations, etc.

The teletype and radio room is an interesting place. At one end are the teletypes, some of which two-way sets are for local messages, to other places in the state, while others connect with other states in New England and outside. This enables the police to exchange information needed for the apprehension of criminals, as well as to give information of emergencies such as floods, etc., where co-operation of the different communities is necessary.

In the center of this room is the telephone desk, where messages come in by phone. These are relayed to the radio turret for transmission to the police cars at various points in the city. On the wall nearby is a large electrical map giving, by means of lights, the location of each car at any given time. A steadily glowing light indicates a waiting car. One flashing on and off indicates that the car is busy, while those not on, indicate cars off duty. Cars are stationed near bridge-heads to close the way if necessary to prevent a criminal from entering or leaving the city.

At the other end of the room is the radio turret where someone is always on duty. It is in communication with all the police stations and cars in

the city. All hear any messages sent out, but only the car with the number called goes to the point assigned. The others hear the call and can, if the designated car calls for aid, rush to the scene of the trouble. A car developing mechanical or radio trouble, or needing gas, notifies the man at the radio turret and is sent to the repair shop or filling station.

Back of the radio room is the panel room for the receiving and transmitting equipment. The high voltage equipment has an auxiliary line from a distant power house connecting with a motor-generator set, so that if the power in the local line is interrupted for any reason, the radio apparatus will continue to work on the other source of power.

The tubes are cooled by water circulating around them. If this water is shut off the apparatus goes off the air. To prevent this, if the city water supply should be disrupted, there is a special pump which will circulate water from a storage tank through the apparatus in much the same way that cooling is brought about in an automobile radiator.

All messages received and sent are recorded in this room by dictaphone and a log is kept, in accordance with government regulations. The dictaphone cylinders are stored in cabinets for the time required, and then are resurfaced in the laboratory and used again.

Finally, in the next room, is the radio testing and repair shop, which tests and repairs any of the sets from the cars when repairs are needed.

JAPAN'S POPULATION PROGRAM FOR 100,000,000 BY 1960 IS MEETING SERIOUS SETBACKS

Japan's recently adopted population program calling for a population increase of 27,000,000 by 1960 to bring the anticipated total in Japan to 100,000,000 is meeting serious setbacks due to the war, Dr. Jesse F. Steiner of the University of Washington has reported to the American Sociological Society.

The Japanese government, which has announced that it is prepared to sacrifice 10,000,000 men in order to defeat the enemy, is at this time, Dr. Steiner stated, faced with a rising death rate both on the home front and war front, as well as a declining birth rate due to the war.

Factors contributing to a declining birth rate, he said, are the hundreds of thousands of Japanese soldiers stationed in remote places and unable to get home and the increasing number of soldiers' widows, who in accordance with long-established custom will not likely marry again.

Therefore, Dr. Steiner stated, it would seem safe to conclude that Japan's period of swarming has definitely ended and may be succeeded by a period of actual population decline in the near future.

SHOCK-ABSORBING PARACHUTE HARNESS

To reduce the severe jolts received by parachute jumpers when the parachute opens, James H. Strong of Windsor, N. Y., has devised a harness in which strong elastic rubber straps or cords are incorporated as part of the lift webs, which connect the harness proper with the parachute shrouds. These are claimed to have sufficient stretch and rebound to ease the opening shock, and thereby leave the user uninjured and ready for instant action on reaching the ground. Patent 2,336,312 has been granted on this device.

THE FORTY-THIRD ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

HAROLD H. METCALF, *Secretary*

The annual convention of the association was held in the Palmer House in the city of Chicago on November 26 and 27, 1943. Planned strictly as a war time conference, the attendance of over 400 teachers indicated a keen interest in the worth-while program which was planned under the guidance of the president, George K. Peterson. A high percentage of speakers submitted manuscripts which will be published in future issues of SCHOOL SCIENCE AND MATHEMATICS.

THE FRIDAY MORNING GENERAL SESSION

Lieutenant Colonel Jay Dykehouse opened the convention with a discussion of pre-induction training. "Don't sugar coat the picture but give the prospective nurse or member of the armed forces sound advice on the realities to be faced in the future. Thorough teaching of the fundamental principles in the basic sciences and in mathematics is necessary. Start with what the student knows and carry him as far as possible in the time available. Give as many illustrations as possible using the vernacular of the service and machines on which the student can get actual experience. The pre-induction course outlines prepared by the government should be used if they meet the needs in any situation." Col. Dykhouse's point of view gave added courage to the teachers to carry on as vital contributors to the nation's war effort.

Professor William A. Albrecht of the University of Missouri spoke on "Grow Foods Or Only Go Foods According to The Soil." He stated that soil fertility determines plant chemical composition rather than plant pedigree. Plants cannot be bred in poor soil. Soil fertility is reflected in animals and human beings. Certain diseases due to malnutrition can be traced to poor soil. Climate is often overemphasized in plant breeding. Fertility of soil makes the retention and use of water by the plants more efficient. Professor Albrecht stressed the importance of growing foods on soils of high fertility. He illustrated his talk with a series of convincing slides.

Professor Harry C. Carver developed the idea of "What Air Navigation Is Not." Coming from the University of Michigan, Professor Carver had made a study of the curricula of air navigation schools. Reorganization is necessary and teaching of air navigation must be based on mathematical and physical principles. Instruction should be in the hands of persons trained in the fields of mathematics, astronomy, and physics. The secondary schools are making a contribution but more guidance should be given in the choice of subjects. The army flying schools are now doing the best job of instruction and can offer the high schools and colleges pointers on how and what to teach in air navigation.

THE FRIDAY NOON LUNCHEON

The plan of substituting a noon informal luncheon for an evening banquet seems on the way to becoming a permanent feature of the convention. Over two hundred members of the association attended the luncheon which was presided over by Nathan A. Neal. Dr. Luther Gable, industrial engineer with the May Company, gave a stimulating lecture and demonstration on "Electromagnetic Radiations." Dr. Gable dealt chiefly with the non-visible radiations beyond the violet end of the spectrum. He illustrated

the effects of such radiation with his equipment and discussed the implications of the use of such radiation in the future.

THE SATURDAY MORNING GENERAL SESSION

Ira C. Davis of the University of Wisconsin High School reported on "The Central Association and Cooperative Work on Pre-induction Courses." Representatives of various organizations of science, health, and home economics teachers discussed with representatives of the U. S. Office of Education and the War and Navy Departments the report on "Physical Fitness Through Health Education for the Victory Corps." This report is now available from the Superintendent of Documents in Washington, D. C., at a cost of twenty cents. The War and Navy Departments strongly urge this health program because it will give prospective members of the armed forces reasons for the regulations that are necessary to the health of the boys.

Professor Davis also stated that a movement is on foot to organize a "Commission on War and Peace For Science and Mathematics." Science and mathematics teachers must develop programs to meet post war needs and they must take some concerted action to make administrators listen to what they have to say.

Lt. Col. William O. Brooks, Chemical Warfare Service, Washington, D. C., read a paper on "The Work of the Chemical Warfare Service." The Chemical Warfare Service effectively has used in the Italian campaign smoke shells, a new 4.2 inch chemical mortar, and flame throwers. New highly adsorptive and activated carbon is being manufactured from wood, soft coal, coke, and sawdust. Now being used in gas masks, the carbon will be used after the war to adsorb objectionable odors in public buildings, kitchens, and refrigerators. Millions of magnesium, thermit, and solidified oil bombs have been manufactured.

BIOLOGY SECTION

(Joint Meeting with the Chicago Biology Round Table)

Presiding: Cecelia Lauby.

Professor I. Owen Foster of Indiana University, spoke on, "Biology for the Armed Forces." Professor Foster most ably showed how the physical science side of the war has a very significant biological and social science setting. Health, physiological effects of environment such as temperature and elevation, and communicable diseases may easily determine the success or failure of a military campaign. Knowledge of animals and plants not only furnishes a source of physical and mental recreation and enjoyment, but it is invaluable in being able to recognize poisonous forms. Especially is this true in the south where coral snakes and rattlesnakes are found, and in the jungles with the strychine bush, machineel tree with its very poisonous oils, and the terrible perai fish. Biology is a functional living science, and with a knowledge of its laws and principles, youth has a foundation upon which the army can build the superstructure practicable in any selected theater of war.

Dr. Louis R. Krasno of the Medical College of Northwestern University Evanston, Illinois, is the inventor of the "Krasno oxygen mask" which fits 95% of the faces. He spoke on "The Biology of Aviation," fundamentals of which are given to men in the air corps. He said that courses in aviation biology and aviation medicine are offered by some universities and work is being done in both sciences by the government and research laboratories. Dr. Krasno divided his lecture into *3* parts due to *3* basic facts:—

1. "Man needs oxygen to sustain life." At an altitude of 12,000–15,000

feet effects of anoxia appear for most aviators and loss of consciousness occurs if an altitude of 25,000 feet is maintained for any appreciable length of time. Use of 100% oxygen makes altitudes of 27,000–33,000 feet possible before effects of anoxia take place, but beyond 44,000 feet life is not possible for any great length of time. At 52,000–62,000 feet no oxygen can enter the lungs because they are full of water vapor and carbon dioxide.

2. "Man cannot ascend to higher altitudes beyond a certain rate of speed." Aeroembolism, commonly known as the "bends" or "chokes," occurs in the body tissues and fluids including dissolved gases, as a result of too rapid decompression. In case air bubbles obstruct blood vessels to the heart or brain, death ensues. Critical rates of ascent vary not only for the individual but at different times for the same individual. An ascent of 12,000 feet per minute up to an altitude of 30,000 feet is generally without aeroembolism, but at 37,000 feet any rate of ascent may produce aeroembolism which, however, can likely be abolished by a descent to below an altitude of 25,000 feet.

3. "Man cannot tolerate changes in speed and direction beyond certain limits." Linear, transverse, and centrifugal are the *3* types of acceleration. A speed of 500 miles per hour in a straight line can be maintained without harm, but, for example, in the case of positive centrifugal acceleration, in a too rapid ascent, a "black-out" occurs due to rush of blood from the head toward the feet, accompanied by muscle cramps, and difficult respiration because the viscera crowd the thorax. "Redding-out" occurs in too rapid a descent, in negative centrifugal acceleration. Blood rushes to the head, consciousness is not lost, but mental confusion may last for several days.

The nominating committee consisting of Mr. A. C. Brookley of Thornton Township High School, Harvey, Illinois, Chairman, Miss Lillian Bondurant of Oak Park and River Forest Township High School, Oak Park, Illinois, and Mr. R. E. Davis of East High School, Aurora, Illinois, gave the following report which was accepted:—

Chairman—A. L. Smith, Central High School, South Bend, Indiana.
Vice Chairman—Ross Aeby, Oak Park and River Forest Township High School, Oak Park, Illinois.
Secretary—Miss Ethel Schierbaum, Harper High School, Chicago, Illinois.

Mr. John Y. Beaty, in his illustrated (in colors) lecture on "Life in the Desert Habitat," easily proved his introductory statement that the "Desert is alive." His poetic interpretation of a number of scenes, in the fore part of his lecture, carried his audience with him to the desert. He especially brought out the relationships of the plants and animals, and their adaptations to soil, elevation, temperature, and rainfall. The juniper tree, yuccas, century plant, and cacti were only a few of the plants discussed. Animals in the desert are most active at night; a rattlesnake placed in the midday sun for a few hours will later die from the effects. Not only reptiles, but several mammals are common in the desert, and birds are more numerous than in our fields, according to Mr. Beaty. He told how the Apache and Navajo Indians cope with the desert and live there as a matter of choice. Mr. Beaty concluded his most interesting and truly educational lecture on the desert, including Death Valley and the Grand Canyon with a view of the "Great White Throne" in Bryce's Canyon.

Ross Aeby, *Secretary*

CHEMISTRY SECTION

Presiding: R. W. Woline

An Experimental Approach to the Generalized Acid-Base Concept—Dr. Herman I. Schlesinger.

Dr. Schlesinger reviewed some of the definitions that have been used to describe an acid; e.g., a substance which could liberate hydrogen by some metal,—liberate CO_2 from a carbonate, a substance which can affect indicators. These were satisfactory for the time in which they were used, but each had its shortcoming.

Then with the coming of Arrhenius' theory of ionization this definition was proposed and had wide acceptance—an acid is a substance whose water solution yields hydrogen ions. But with the use of solvents, other than water, this definition was no longer strictly true. When liquid ammonia was the solvent, one definition was used, but with a different solvent a different definition was needed.

One of the fundamental difficulties involved in the whole problem was the fact that the writers were continually trying to incorporate in the definition, the concept of the strength of the acid and since these two phases of the term are not on the same plane, a satisfactory definition can never be formed. The same acid in different solvents displays different degrees of strength. The result of many experiments using different acids with various solvents led Dr. Schlesinger and others to believe that the only way to define an acid and its strength is to compare it with a particular base.

Some Problems in Tin Conservation—Dr. R. W. Pilcher.

Dr. Pilcher began by showing that 80% or more of the normal supply of tin comes from territory now in enemy hands so our supply is greatly reduced. Also that solder and tin plate together use about two-thirds of our annual production of tin so if conservation was to be effected, these were the lines that should receive the most attention.

Research on solder composition has lowered the tin content to about half its former proportion and shortly a solder will be marketed with only 5% tin.

Also through concentrated experimentation the tin construction of the "tin can" has changed so that by the use of bonderized steel, electrolytic deposition of the tin, and enamel coating, the tin can of 1943 uses less than one pound of tin per 1000 cans, while the 1940 style used about 4 pounds of tin for the same number of cans.

High School Chemistry A Master Teacher (Frank B. Wade), Four Decades of Time, and the Results—Mr. Walter Geisler.

Mr. Geisler called Mr. Wade a "Master Teacher." Mr. Wade has been in Indianapolis for over forty years, but he has remained definitely "young in spirit."

Being interested in and really loving his work as teacher, sympathetic toward young people, always alert to the new developments in science, he has been able to grow old in such a way that his age has added much value to his work in the schools.

Having strong convictions of what science should give to young people, he has not always followed the conservative styles, but the results in the lives of his students have proved the wisdom of his methods. In addition to being a good science teacher, he is an expert on gems and has written three popular and authoritative books on this subject.

FRED W. MOORE, *Secretary*

ELEMENTARY MATHEMATICS

Presiding: Butler Laughlin

The meeting opened with remarks by the chairman, Butler Laughlin. Mr. Leonard Anderson, substituted for Mr. Lawrence Casey of the Monte-

fiore School, Chicago. Mr. Anderson gave a picture of the type of boy found at the Montefiore School; a boy very anti-academic. The "work type" of reading is emphasized rather reading for pleasure. An Arithmetical vocabulary is stressed. Arithmetic must be made interesting by the use of a vocabulary that can be understood by the children. Verbal problems need to be made interesting to the boys of the Montefiore School. There is oral reading of verbal problems at least once a week. It is necessary to show the child how to read and study.

The Teaching of Quantitative Thinking—A Demonstration—Mr. H. O. Gilett

Twenty bright pupils of the seventh grade of St. Mary Magdalen School assisted Mr. H. O. Gilett, Principal of University Elementary School, Chicago. Mr. Gilett had never seen the children before. He set out to prove that "we can train people to think." Mr. Gilett used concrete articles such as quart and pint fruit jars; quart, pint, and half pint milk bottles. He had the children compare a pint to a quart, ½ pint to a pint, ½ pint to a quart and then introduced the use of percentage to show the relationships. Mathematical concepts can best be taught by using familiar things as a basis for thinking.

Dr. E. T. McSwain of Northwestern University spoke on "Trends in the Teaching of Arithmetic in the Elementary School." He stated that arithmetic is a way of thinking in quantity relationships. The world is a dynamic unity in which children learn by comparison. A quantity is known by its relationship to another quantity. The teacher's role is not to teach arithmetic but to provide experiences for the learning of arithmetic.

VIOLET WEISEN, *Secretary*

ELEMENTARY SCIENCE SECTION

The annual meeting of the Elementary Science Section of the Central Association was called to order Friday, November 26, 1943, at three o'clock, by Miss Anna E. Burgess, Chairman. The Minutes of the last meeting were read and approved. A nominating committee composed of Dr. Paul Kambly, Miss Mary Melrose and Miss Elizabeth Davies was appointed by Miss Burgess, the chairman.

The program opened with a very dynamic and interesting demonstration on the "Stars" given by a fourth grade class of Miss Laura Watkins from Columbus School, Cicero. In her demonstration she made a very effective use of one phase of the scientific method, an excellent use of reference material and also the use of experiments to prove her points.

The next speaker on the program was Mr. John Sternig, Science Counsellor, Glencoe, Illinois, who spoke on "Astronomy in the Elementary Schools." Mr. Sternig stressed the universal appeal of astronomy by children of all ages. He also brought out the fact that too often we put off astronomy till the child reaches Junior High School age and by that time his curiosity has quieted down. He also stated that there were 4 things that were very important in teaching this unit.

(1) It must be well done and well planned.
(2) It must take care of special interests.
(3) There must be a great many experiments and activities.
(4) It must be dramatic.

Mr. Sternig then showed how he thought these objectives could be reached through a great variety of activities. He concluded with saying that he was more concerned with attitudes developed toward these things than facts—that children should be made to realize the great space and distance and also a real consciousness of God—the Creator of all these things.

Miss Mary Melrose, Supervisor of Elementary Science, Cleveland, Ohio, spoke on "Children's Projects in Conservation." She stressed the point how conservation activities carried on in the school could help the child to make constructive use of his dynamic energy instead of being used in the wrong channels. She went on to relate a number of different projects that were being carried on in the Cleveland Public schools and how this was helping these children, who, as a result of the war were more or less on their own, to make effective use of their leisure time. Miss Melrose also listed a number of books that she thought would be helpful to the elementary teacher in her work on conservation.

Dr. Paul Kambly, chairman of the nominating committee, recommended the following officers for 1943–1944, who were elected.

Chairman, Miss Hazel A. Seguin, Science Supervisor, Superior State Teachers College, Superior, Wisconsin.

Vice-Chairman—Miss Clara L. Steyaert, Teacher of Elementary Science, Davenport, Iowa.

Secretary—Miss Hildegard C. Pieper, Science Teacher, Harte School, Chicago, Illinois.

CLARA STEYAERT, *Secretary*

GEOGRAPHY SECTION MEETING

Presiding: Floy Hurlbut.

The geography section meeting was attended by a rather large group of teachers. Due to the illness of Dr. Harris of the University of Chicago, Mrs. Harris read his paper. The demonstration lesson in charge of Monica H. Kusch, the panel discussion, and Mr. W. G. Gingery's talk on "Map Projection for an Air Age" were all very interesting.

MONICA H. KUSCH, *Secretary*

MATHEMATICS SECTION

Mr. Franklin Frey, chairman, called the meeting to order at 3 P.M., November 26, in Private Dining Room 18 of the Palmer House. Mr. Edward G. Hexter, vice-chairman, and Miss Mildred Taylor, secretary, were also present.

Professor Harry C. Carver of the Department of Mathematics, University of Michigan, gave a vigorous and stimulating talk on "Air Navigation and the Secondary Schools" in which he developed the thesis, "Mathematics is Useful in Air Navigation," basing his talk on the rich background of his experience gained in the U. S. Army Air Corps and his teaching and research in the field of mathematics and air navigation. He explained that when the Army started the training of pilots they needed young men with training in the fields of plane and spherical trigonometry and physics, but enough young men with these desired prerequisites were not available, and so the Army had to take the candidates they had, and do what they could with them. Therefore, mechanical computers and scale drawings were used to solve problems, since the results obtained were accurate enough for the purpose. However, the speaker expressed the opinion that more and more use will be made of the mathematical solution of problems in air navigation, since there are some problems which cannot be solved by the above methods, and others which can be solved more quickly by trigonometric formulas when these have been derived.

After stating that the four means of navigating a plane are pilotage, dead reckoning, celestial navigation, and radio navigation, Professor Carver gave these specific examples of the use of mathematics; he set up a pair of simultaneous trigonometric equations that are valuable in com-

puting ground speed; he explained how mathematics could be used in celestial navigation by determining three sub-stellar points and computing the location from these; he showed how radius of action problems are easily solved by elementary mathematics and also offer a splendid opportunity to demonstrate harmonic means; and, lastly, he demonstrated how a double drift problem could be solved by an easy formula derived by expanding the function set up in a converging Taylor's series.

"Mathematics has a tremendous future in air navigation, both in celestial navigation and dead reckoning," he said. "Aviation of the future will use an increasing amount of mathematics, and navigators will have to be better trained," was his concluding statement.

Mr. Harry M. Keal, head of the Department of Mathematics, Cass Technical High School, Detroit, launched his topic, "The Philosophy of Technical Mathematics," by pointing out that evidences of culture have always come through the technical skills—that the genius of the artist, the architect, the designer, the automotive engineer, was dependent on technical skill for its fruition. The speaker then traced technical education from the turn of the century when a new type of technical education was replacing the old apprentice system, and showed how the growth of technical training at Cass Technical High School paralleled the growth of the automotive industry in Detroit. He said the highest type of mechanical mind gravitated toward engineering, and behind these rose rank after rank of technicians with differing degrees of skill and knowledge, needing varying mathematical backgrounds.

"Service is back of the philosophy of technical education," Mr. Keal said. The student should be directed to courses commensurate with his ability, so that each can serve to his greatest capacity and so be a valuable citizen in his community. Every effort should be made to bring each student to the highest level of which he is capable. To achieve this the speaker suggested: adding to the hand skills the knowledge of science and mathematics that connect them to life; giving each pupil credit for only those levels he attains, since it is better to fail in school than in life; insisting on those of medium ability acquiring more than the lowest skills; and maintaining special classes for those who are very, very weak in mathematics so that they can be given every opportunity under special training to acquire the fundamental processes of mathematics.

"Not only should the pupil *regain* mastery of the fundamentals when he is a senior by refresher courses—he should *retain* this mastery and achieve accuracy in his computations." Mr. Keal suggested drill or "repetitive education" to insure mastery, so that each pupil can *serve* well with the knowledge and skill that is his.

The report of the nominating committee consisting of Dr. H. G. Ayre, Macomb, Ill., Dr. William Krathwohl, Chicago, Ill., and Miss Anne Suter, Indianapolis, Ind., was presented by Dr. Ayre. The following officers were elected for 1944: Chairman, Mr. Edward G. Hexter, Belleville Township High School, Belleville, Ill.; Vice-Chairman, Miss Mildred Taylor, Fenger High School, Chicago, Ill.; and Secretary, Mr. G. A. Waldorf, Township High School, Waukegan, Ill.

MILDRED TAYLOR, *Secretary*

CONSERVATION GROUP

Presiding: Charlotte Grant

Professor W. A. Albrecht of the University of Missouri presented a paper on "Soil Conservation for Health's Sake." He showed kodachrome slides of Missouri plant demonstration areas and of farm animals. He further developed the theme of his Friday address and showed the direct

relationship between soil fertility and healthy plants, animals, and humans.

Mr. Olin Capps of the Missouri State Conservation Commission directed a panel discussion on "Conservation Education for Teachers." Mr. O. E. Fink, Dr. O. D. Frank, and Miss Mary Melrose participated. The conservation laboratory at Tar Hollow, Ohio, has a four-year history of attendance by science, social science, economics, and mathematics teachers. Conservation becomes a dominant phase of courses of study in respective schools represented instead of a unit to be omitted if there is lack of time. Textbooks are not used but each teacher studies a one-acre plot. Vegetation maps, contour maps, soil profiles, and animal studies are made.

Dr. Frank stressed the following points: conservation education should be begun before high school; conservation should be taught in great out-of-doors; conservation must be sold to teachers; conservation study should be started with broad basic ideas and progress to the individual; conservation activities might consist of getting rid of some things such as burs and cultivating others such as toads.

Miss Mary Melrose stated that conservation must become a habit of doing rather than just an idea; that conservation should ramify all subject fields beginning in the second grade with home and school projects; conservation in the third grade stresses early destruction of forests and soil by pioneers; conservation in the fourth grade stresses protection of plants; conservation in the fifth grade shows interrelationships of plants and animals; and conservation in the sixth grade considers conservation of soil and water. Active participation in some conservation project in the community adds meaning to the work.

JUNIOR HIGH SCHOOL GROUP

Presiding: Pauline Royt

Many vital points in the teaching program were brought out in the topic discussed at this meeting. William A. Porter of the University High School at Madison, Wisconsin, stressed teacher interest and teacher philosophy in his topic on "A Proposed Science Sequence." Like many others, he expressed the view that the curriculum is a tool that can be used well or poorly depending upon the teacher. The success of a curriculum depends upon the teacher's philosophy and this is largely formed during his teacher-training period. His philosophy must incorporate application of principles as opposed to absorption of facts, and recognition of his duty to teach each child to the maximum of its ability. Mr. Porter brought out in his discussion the dominating weaknesses in junior high school pupils and suggested remedying those weaknesses by the science teacher himself in his teaching. One should examine current speed-up work in the Army and Navy and use those methods to improve the science program and thus eliminate the "deadwood." Much "deadwood" results from the courses which are built up on repetition. He suggested six units a semester in seventh- and eighth-grade general science with biology in ninth grade. This would give, then, a year and a half for both chemistry and physics. He gave the order of topics which would result in the best understanding in a program of this sort.

As one usually expects, Mary A. Potter, Supervisor of Mathematics, Racine, Wisconsin, gave the junior high school group many ideas of what and how things may be used in making mathematics a concrete instead of an abstract subject. She gave a vivid picture of the mathematics laboratory. In this room were cabinets—many cabinets to store supplies just as in the science laboratory. The cabinets are used to display and keep things fresh looking. Just a few of the long list of things she gave that would be housed in these cabinets were: thermometers, scales for weighing things,

boxes of stage money, measuring devices for liquids, measuring cups, tablespoons, rope, cotton tape, scissors, squared paper, crayons, paste, business forms, and picnic plates. She suggested a mathematics Christmas tree with its paper ornaments as a "painless form for teaching of solids." Two bulletin boards which could be moved were suggested for news items. One board was on display while the other was in preparation. The mathematics club, also, plays a vital part in preparing and arranging material in the mathematics laboratory. Miss Potter gave many suggestions and told how most of them could be used in the classroom.

A climax in any program is the challenge which results from presenting a different point of view. Dr. Paul E. Kambly of the School of Education University of Iowa, presented in his topic, "The Junior High School Science Program," a very challenging discussion on the science program as it will continue to develop. He said that the gap between elementary nature study and senior high school science has practically disappeared as a result of: first, the general science program in the seventh and eighth grade and second, the elementary science program. Again, as in Mr. Porter's topic, the repetition of science units covered in the elementary, junior and senior high school represents a problem. There is a motivation stagnation which is becoming apparent as a result of the lack of cooperation in building the proper science sequence. A plan has already been proposed which will hook up the social studies and science from the first grade through college. The correlation of science and social studies in the junior high school is sound in principle and only the difficulties in presenting the material in a new relationship will have to be worked out by the up-to-date teacher with his ever changing pupils and curricular problems.

MARK P. ANDERSON, *Secretary*

JUNIOR COLLEGE GROUP

Presiding: Edwin W. Schreiber

The meeting was called to order by the presiding officer, Mr. Edwin W. Schreiber, Western Illinois State Teachers College, Macomb, Illinois. After a few preliminary remarks, he introduced the first speaker of the morning, Robert E. Schreiber, Department of Visual Aids and Radio, Stephens College, Columbia, Missouri, who presented a very interesting and timely paper on: "The Use of Films as a Teaching Aid." The first half of the paper was concerned in discussing the general problem of using films in the field of education; the second part dealt with the particular set-up at Stephens College.

"On Editing a Scientific Journal" was the title of a most interesting paper presented by Dr. Glen W. Warner, Editor of SCHOOL SCIENCE AND MATHEMATICS for the past seventeen years. The speaker traced briefly the early history of the Journal which was founded by Charles E. Linebarger (1867–1937) in March, 1901. Charles H. Smith (1861–1926) was the editor from 1905–1926. Mr. Warner gave us many intimate details on editing a journal during these troublesome times.

The third speaker, Professor Harold Thayer Davis, Northwestern University, spoke on the title: "Archimedes and Mathematics." Professor Davis began his paper by inviting his audience to attend a dinner party given by the King in honor of Archimedes in the year 250 B.C. We were introduced in a very entertaining manner to each member of the party and thus became acquainted with the personal friends of Archimedes. Later we were informed of many ingenious inventions of this intellectual giant of antiquity, from the first "jig-saw" puzzle to the area under a parabola (the germ of the integral calculus).

NOTES OF GENERAL INTEREST

The officers of the Association and of the various sections elected for the year 1943–1944 are listed in this issue of the magazine on page vii. Not every section chairman gave a detailed report of the program because most of the speakers submitted manuscripts which will appear in this and future issues of SCHOOL SCIENCE AND MATHEMATICS.

The Board of Directors voted a life membership in the Central Association of Science and Mathematics Teachers to Mrs. W. F. Roecker, in recognition of her long record of great service to the Association.

Dr. Edwin W. Schreiber of Western Illinois State Teachers College was appointed historian for the Association. Not only will he glean from the past records of the Association many facts of interest to present and future members but he will also prepare a handbook of information which will be of help to new members and officers.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

BOARD OF DIRECTORS MEETING, FRIDAY, NOVEMBER 26, 1943

President George K. Peterson called the meeting to order at 7:30 P.M. The following members were present: Mr. Schreiber, Mr. Georges, Mr. Baker, Mr. Hanske, Mr. Hewitt, Mr. Massey, Mr. Dickman, Mr. Oestreicher, Mr. Kambly, Mr. Christofferson, Mrs. Johnson, Mr. Mayfield, Mr. Park, and the secretary.

Absent, Mr. Johnson, because of illness.

Mr. Peterson briefly outlined the progress of thinking and acting during his administration. The year has been one of many uncertainties caused by the war and at one time there was strong pressure to discourage travel and conventions by the office of transportation. However, a questionnaire study indicated a majority in favor of holding the annual meeting with the result that a very successful convention culminated.

O. D. Frank, chairman of the necrology committee, reported no deaths during the year other than that of Franklin T. Jones which was written up in SCHOOL SCIENCE AND MATHEMATICS.

Mr. Schreiber reported that his study showed a total of 134 officers of the Association in a period of 43 years with only 16 deaths reported. This number seems too small. The first meeting of the Association was held in November in 1902. Chas. H. Smith was president in 1902, 1903, and 1904. Otis Caldwell was president in 1905 and 1906. Mr. Schreiber then implied by a question that our Association was old enough and important enough to have a historian.

Mr. Georges moved, Mr. Baker seconded, and it was passed, that: The Board of Directors appoints Edwin W. Schreiber to be official historian of the Central Association of Science and Mathematics Teachers.

Mr. A. O. Baker, chairman of the place of meeting committee, reported that his committee gave very careful consideration to going elsewhere for the 1944 meeting. Being aware of the outstanding job done in Chicago and being aware of the many war problems that would become greater if a move were made, the committee unanimously proposed Chicago for the 1944 convention.

Mr. Schreiber moved, Mr. Massey seconded, and it was passed, that: Chicago be the city of the 1944 convention.

Miss Charlotte Grant, chairman of the conservation committee, submitted the following report:

1. No written report based on a study was made in 1943.

2. The Saturday morning conservation section program was prepared by the committee.
3. The committee urges the establishment of a permanent Saturday morning conservation section.
4. F. Olin Capps, Conservation Commission of Missouri, is suggested as chairman for the 1944 Conservation Group.
5. The proposal for next year's emphasis: food and its effects on the body; water and its conservation; project possibilities in conservation teaching.

Mr. Georges moved, Mr. Baker seconded, and it was passed, that: The Conservation Group be established as a permanent group to meet on Saturday mornings.

Mr. Baker commented that the conservation committee had come through a long struggle in hopes that such a section would be created.

Mr. Park, chairman of the resolutions committee, presented the following report.

1. Whereas, the present national emergency necessitates greater cooperation in the fields of science and mathematics, and

Whereas, the meetings of the Central Association of Science and Mathematics Teachers offer opportunities for such cooperation and exchange of ideas;

Be it hereby resolved, that we recommend the holding of a convention in 1944.

2. Whereas, the present transportation problem necessitates a minimum use of railway facilities, and

Whereas Chicago offers the shortest travelling distance for the greatest number of people;

Be it hereby resolved, that the convention be held in Chicago next year.

3. Whereas, political and business leaders are considering plans for the post-war era, and

Whereas, every past war has produced great technical changes, with their accompanying problems;

Be it hereby resolved, that the convention program next year give thoughtful consideration to post-war planning in mathematics and science.

4. Whereas, during the period of crisis it has been extremely difficult to make definite plans, and

Whereas, those responsible for such planning have been carrying unusually heavy loads incident to the war effort;

Be it hereby resolved, that we extend to those in charge of this year's convention our thanks for their highly successful efforts.

Mr. Massey moved, Mr. Oestreicher seconded, and it was passed, that: The report of the resolutions committee be accepted.

Mr. Dickman, chairman of the local arrangements committee, reported that the work of his committee extended out through the school and teacher organizations in the city. The smooth functioning of the convention is an indication of the work accomplished.

Mr. Oestreicher moved, Mr. Massey seconded, and it was carried that: A vote of thanks be extended to the local arrangements committee for their fine work.

Mrs. Johnson, chairman of the membership committee, reported:

1. 702 members in membership chairman's file on November 26, 1943.
2. Expense of membership committee $61.57
3. Membership and guest registration at convention.

143 memberships	$357.50
186 guests at $.50	93.00
Total	$450.50

This money was audited by the hotel and a check made to the Central Association of Science and Mathematics Teachers and given to Mrs. Soliday.

4. Recommendations for committee personnel for 1943–1944. Mr. Smith is retiring. Suggested successor is Phillip Gilman of Rawlings Junior High School of Cleveland, Ohio. Mr. Neal made suggestion.

Delma Harding of Iowa is retiring. Suggested successor is Don Cassill, Stuart Junior High School of Ottumwa, Iowa.

W. W. Lauterbach of Indiana is retiring. Suggest reappointment since he is willing to serve again.

The expiring terms of members of the membership committee should be indicated in the yearbook.

Seven dollars was spent at the convention for clerical help by the membership committee.

Mr. Schreiber moved, Mr. Georges seconded, and it was passed, that: The bills of the membership committee be paid.

Mr. Massey moved, Mr. Dickman seconded, and it was passed, that: The report of the membership committee be accepted and thanks extended to Mrs. Johnson and to members of her committee for a job well done.

Miss Lowes, local membership chairman, reported that:

A representative was appointed for each of the city high schools and the schools divided up among the members of her committee.

Junior colleges were included in the membership drive.

All committees and officers were checked to determine whether they were members of the association.

A letter and yearbook were mailed to each of the 84 high schools in the archdiocese.

Guests of the 1942 convention were mailed a letter and invited to join the association.

Letters were mailed and phone calls were made to the delinquent members.

The principals of New Trier and Evanston high schools were contacted with good response.

There are at present 242 Chicago public school teachers and 48 Catholic school teachers in the association.

Recommendations submitted to the board of directors by the committee are not included here.

Mr. Oestreicher moved, Mrs. Johnson seconded, and it was passed, that: The report of the local membership committee be accepted with thanks. The recommendations of the committee will be given further consideration.

Hans Gutekunst, chairman of the Journal display committee, submitted the following report in writing. The table for the Journal Display Committee was placed in an ideal spot. Approximately 75% of all visitors passed the exhibit. A display of mathematics projects by Mr. V. A. Elvers of Cass Technical High School of Detroit attracted considerable attention.

Reprints sold and delivered	$1.20
Reprint ordered	.15
Sent to treasurer	$1.35

The only expense was the express for the Elvers exhibit.

Mr. Ira Davis, as a representative of our association, at the expense of the government made a trip to Washington to act on a committee studying various phases of pre-induction training. Mr. Norman Jones, president of the American Council of Science Teachers, attended the board meeting with Mr. Davis and together they presented a plan for a national commission on war and peace.

In the ensuing discussion, Mr. Georges remarked: Our association is interested in cooperating with such a commission made up of representatives of other organizations but is not interested in a commission which is inviting membership of individuals as individuals. Mr. Massey concurred in this opinion. This association is not interested in the formation of a competitive organization.

Mrs. Johnson moved, Mr. Christofferson seconded, and it was passed, that: The president appoint a committee to study the recommendations and report back to the Saturday board meeting.

President Peterson appointed Mr. Mayfield, Mr. Georges, and Mr. Massey, chairman.

Mr. Ray Soliday, business manager of the Journal, and Mrs. Soliday reported on their work. Mr. Soliday stated that Mrs. Soliday does quite a bit of the detailed work on the Journal. He suggested that the board of directors recognize the work of Mrs. W. F. Roecker in some way in addition to that already done. Mr. Soliday thanked Mrs. Johnson and Mrs. Lowes for the work done by the membership committees. In addition, Mr. Soliday submitted a mimeographed report.

Mr. Metcalf strongly urged the immediate increase in advertising rates.

Mr. Hawkins, chairman of the Journal committee, reported. He advised that the directors not act immediately on Miss Lowes' suggestion on termination of subscriptions. The Journal committee and the business manager are both studying the problem. After a subscription expires, one additional issue of the magazine is sent. Every effort is made to keep good will and not antagonize. Mr. Soliday is encouraged to continue his practice of inviting subscribers into membership. This will save agency fees. The audit shows a net loss for the magazine in 1942–1943 of $229 and a net profit for the convention of $30 (1942 convention). Last year it cost $6500 to print SCHOOL SCIENCE AND MATHEMATICS. This year it will cost $6750. The budget included the printing item at $6300. Either an increase in advertising of two or three pages a month or an increase of $5 a page in advertising rate will pay this differential.

Mr. Massey moved, Mr. Christofferson seconded, and it was passed, that: In view of the uncertainties of the future and the possibility that prices will stay up for some years to come, authority is given to the business manager, with consent of the Journal committee, to increase advertising rates or increase the number of pages of advertising or both if necessary to meet the situation.

Mr. Schreiber moved, Mr. Oestreicher seconded, and it was passed, that: The business manager be empowered to make new arrangements for the annual audit of all association accounts.

It is suggested that in the space used for Mr. Franklin Jones' problem department, Mr. Warner run a question as to desirability of keeping such a department in the future. Conclusion should be based on replies from readers.

Mr. Hewitt moved, Mr. Park seconded, and it was passed, that: The board of directors accept the report of the Journal committee and Mr. Soliday.

Mr. Schreiber moved, Mr. Massey seconded, and it was passed, that· The problem of recognition for Mrs. Roecker be laid on the table unti the next board meeting.

Mr. J. E. Potzger, manager of the yearbook made the following report:

Total advertising and exhibit space sold	$871.50
Commission and expense	728.32
Balance	$143.18

Mr. Georges moved, Mr. Schreiber seconded, and it was passed, that: Mr. Potzger's report be accepted and the board extend him a hearty vote of thanks.

Mr. Schreiber moved, Mr. Hewitt seconded, and it was passed, that: The meeting be adjourned.

1942–43 BOARD MEETING, NOVEMBER 27, 1943, 1:30 P.M.

Mr. Metcalf attended a meeting with the new section officers. President Peterson appointed Mr. Oestreicher to act as temporary secretary.

Those present were Mr. Peterson, Mr. Schreiber, Mr. Hanske, Mr. Hewitt, Mr. Massey, Mr. Dickman, Mr. Oestreicher, Mr. Kambly, Mr. Christofferson, Mrs. Johnson, Mr. J. T. Johnson, Mr. Park.

Those not present were Mr. Georges, Mr. Baker, and Mr. Mayfield.

It was moved by Mr. Kambly, seconded by Mr. Johnson, and passed that: Mrs. Roecker be given a life membership in the Central Association of Science and Mathematics Teachers. The secretary is to inform the business manager and also write a suitable letter to Mrs. Roecker.

Mr. Massey gave the report of the committee appointed to study the national commission recommendations as follows:

We recommend that this organization, the Central Association of Science and Mathematics Teachers, cooperate with a national commission on science teaching by sending a representative to an organization meeting of the commission, this representative to report back to the May meeting of the Board of Directors for further study.

It was moved by Mr. Schreiber, seconded by Mr. Kambly, and passed, that: The report of the committee be accepted and the president be authorized to appoint a delegate.

It was moved by Mr. Kambly, seconded by Mr. Schreiber, and passed that: The president use his discretion in regard to the expense of such a trip for the delegate.

It was moved by Mr. Schreiber, seconded by Mr. Christofferson, and passed, that: The bills presented by Mr. Peterson for expense of the convention be paid.

The 1942–43 board adjourned.

President Massey called the new board to order. Mr. Carnahan, Mrs. Mikesell, and Mr. Trump sat in as new members.

The new board elected Mr. Metcalf secretary for 1943–44.

Mr. Oestreicher moved, Mr. Christofferson seconded, and it was passed, that: The executive committee be composed of Mr. Massey, Mr. Peterson, and Mr. Dickman.

The spring board meeting is tentatively set for Saturday, May 13, 1944, at 9:00 A.M.

Mr. Peterson moved, Mr. Christofferson seconded, and it was passed, that: The president write to the educational heads of schools informing them of participation of teachers in their schools who act as section officers, speakers, or directors in our association. Also that the president use his discretion in suggesting that expense money be allowed for meeting attendance of such members.

A number of directors requested that the last part of the motion not apply to them.

Mr. Kambly moved, Mr. Dickman seconded, and it was passed, that: A copy of the minutes of the board of directors be sent to Miss Lowes and that she be informed of the policy of the Association which allows for the examination of the minutes by a member of the Association.

The meeting was adjourned.

As historian of the Association, Mr. Schreiber may get out some information of value to new members and to new members of committees.

The above minutes for the meetings of the Board of Directors of the Central Association of Science and Mathematics Teachers may need correction. Please communicate with me if you find errors.

HAROLD H. METCALF, *Secretary*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in Indian ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1837, 8, 9, 42. *Daniel Finkel, Washington, D. C.*

1839. *Helen M. Scott, Baltimore, Md.*

1837, 8, 9. *Harvey Rubinstein, Brooklyn, N. Y.*

1837, 8, 9, 40, 41. *A. E. Gault, Peoria, Ill.*

1843. *Proposed by Hugo Brandt, Chicago, Ill.*

If vertex C of parallelogram $ACBD$ is the center of a circle passing through D, and if vertices A and B lie on the radii CAA' and CBB', find the diameter of the circle if $AA'=4$, $BB'=5$, and the diagonal $AB=7$.

Solution of Adrian Struyk, Paterson, N. J.

Let $CA'=CD=CB'=r$. Then $CA=BD=r-4$, $CB=AD=r-5$. Since the sum of the squares of the sides of a parallelogram is equal to the sum of the squares of the diagonals

$$2(r-4)^2+2(r-5)^2=r^2+7^2.$$

Hence

$$r^2-12r+11=0, \quad \text{and} \quad r=11 \text{ or } 1.$$

All conditions are satisfied by a circle of diameter 22. The parallelogram degenerates into a line-segment of length 7 if the diameter is 2, and the orders CAA', CBB' do not hold.

Solutions were also offered by Aaron Buchman, Buffalo, N. Y., Hugo Brandt, Chicago; A. E. Gault, Peoria, Ill.; Helen M. Scott, Baltimore, Md.; M. Kirk, West Chester, Pa.; David Rappaport, Chicago; M. M. Dreiling, Collegeville, Ind.; Gordon Duwall, Cincinnati, Ohio; Harvey Rubinstein, Brooklyn, N. Y.; Carl Friedrich, Ford City, Pa.; Walter R. Warne, Fayette, Mo.

1844. *Proposed by Hugo Brandt, Chicago.*

Given an infinite series whose general term,

$$a_n=\frac{2n+1}{n^2(n+1)^2}\cdot$$

Let S_k be the sum of the first k terms and $S_{k'}$ be the sum of the rest of the series. If the difference $S_k{}^2-S_{k'}{}^2=.98(S_k+S_{k'})$, find k.

Solution by A. Wayne, Flushing, L. I., N. Y.

$$S_k=\sum_1^k\left[\frac{1}{n^2}-\frac{1}{(n+1)^2}\right]=1-\frac{1}{(k+1)^2}\cdot$$

Hence $S_k+S_{k'}=1$ and since $S_k{}^2-S_{k'}{}^2=.98(S_k+S_{k'})$

$$S_k-S_{k'}=.98 \quad \text{or} \quad S_k=\frac{.98+1}{2}\cdot$$

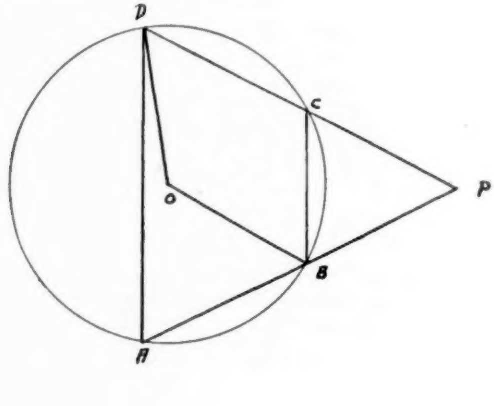
Whence

$$1-\frac{1}{(k+1)^2}=.99 \quad \text{and} \quad k=9.$$

A solution was also offered by the proposer.

1845. *Proposed by B. M. Etrinne, Montreal, Canada.*

If a trapezoid be inscribed in a circle, the center of the circle, two opposite vertices of the trapezoid and the point of intersection of the non-parallel sides produced are concyclic.



Solution by Gordon Duwall, Cincinnati, Ohio.

Let $ABCD$ be the given trapezoid. It is obvious that it must be an isosceles trapezoid so arc DC = arc AB.

$$\angle O = \text{arc } DC + \text{arc } CB$$

$$\angle P = \frac{\text{arc } DA}{2} - \frac{\text{arc } CB}{2}$$

$$\angle O + \angle P = \text{arc } DC + \frac{\text{arc } DA}{2} + \frac{\text{arc } CB}{2} = 180°.$$

Since the opposite angles of the quadrilateral are supplementary the quadrilateral $DOBP$ is concyclic.

Solutions were also offered by Marcellus M. Dreiling, Collegeville, Ind.; Adrian Struyk, Paterson, N. J.; M. Kirk, West Chester, Pa.; A. E. Gault, Peoria, Ill.; Aaron Buchman, Buffalo, N. Y.; Jacob L. Chernofsky, Brooklyn, N. Y.; B. F. Frankel, Camp Crowder, Mo.; Hugo Brandt, Chicago; Harvey Rubinstein, Brooklyn, N. Y.; Morris I. Chernofsky, New York City.

1846. *Proposed by Harvey Rubinstein, Brooklyn, N. Y.*

Resolve into factors $a^3+b^3+c^3-3abc$.

Solution by Ralph Mansfield, Chicago.

$$\begin{aligned} a^3+b^3+c^3-3abc &= (a+b+c)^3 - 3(a+b+c)(ab+bc+ca) \\ &= (a+b+c)\left[(a+b+c)^2 - 3(ab+bc+ca)\right] \\ &= (a+b+c)\left[a^2+b^2+c^2-ab-bc-ca\right]. \end{aligned}$$

Let

$$\omega = -\frac{1}{2} + \frac{\sqrt{3}}{2}\, i, \quad \text{so that} \quad \omega^2 = -\frac{1}{2} - \frac{\sqrt{3}}{2}\, i \quad \text{and} \quad 1+\omega+\omega^2=0, \quad \omega^3=1.$$

Then

$$a^2+b^2+c^2-ab-bc-ca = (a+\omega b+\omega^2 c)(a+\omega^2 b+\omega c).$$

Hence

$$a^3+b^3+c^3-3abc = (a+b+c)(a+\omega b+\omega^2 c)(a+\omega^2 b+\omega c).$$

Solutions were also offered by Marcellus M. Dreiling, Collegeville, Ind.; Aaron Buchman, Buffalo, N. Y.; M. Kirk, West Chester, Pa.; A. Wayne, Flushing, L. I., N. Y.; James Smich, Lake City, Mich.

1847. *Proposed by Clyde A. Bridger, Salt Lake City, Utah.*

If a, b, c are roots of $x^3+px^2+qx+r=0$ find the value of Σa^4 in terms of p, q, and r.

Solution by A. Wayne, Flushing, L. I., N. Y.

Since

$$a+b+c=-p \qquad [1]$$

$$ab+ac+bc=q \qquad [2]$$

$$abc=-r \qquad [3]$$

$[1]^2$ gives

$$a^2+b+c^2+2(ab+ac+bc)=p^2$$

or

$$a^2+b^2+c^2=p^2-2q.$$

Squaring again:

$$a^4+b^4+c^4=(p^4-4p^2q+4q^2)-2(a^2b^2+a^2c^2+b^2c^2) \quad [4]$$

$[2]^2$ gives

$$a^2b^2+a^2c^2+b^2c^2+2abc(a+b+c)=q^2$$

and substituting from [2] and [3] and combining with [4], we have

$$a^4+b^4+c^4=p^4-4p^2q+4pr+2q^2.$$

Solutions were also offered by Marcellus M. Dreiling, Collegeville, Ind.; Adrian Struyk, Paterson, N. J.; Morris I. Chernovsky, New York City.

1848. *Proposed by Clyde A. Bridger, Salt Lake City, Utah.*

A rabbit is now a distance equal to 50 or her own leaps ahead of a fox which is pursuing her. How many leaps will the rabbit take before the fox overtakes her if she takes 5 leaps while the fox takes 4, but 2 of the fox's leaps are equivalent to three of the rabbit's? Also how many fox leaps were made?

Solution by Jerry Johnson, Hammond, Ind.

Let x = the no. of leaps the rabbit will take before the fox overtakes her.
$x+50$ = the no. of the rabbit's leaps the fox must travel to overtake the rabbit.
$\frac{2}{3}(x+50)$ = the no. of its own leaps the fox must make to overtake the rabbit.
$\frac{4}{5}x$ = the no. of its own leaps the fox must make to overtake the rabbit.

$\frac{2}{3}(x+50)=\frac{4}{5}x$
$10x+500=12x$
$2x=500$
$x=250$, no. leaps the rabbit takes.
$\frac{4}{5}x=200$, no. leaps the fox takes.

Solutions were also offered by W. R. Smith, Gainesville, Fla.; Helen M. Scott, Baltimore, Md.; M. Kirk, West Chester, Pa.; Adrian Struyk, Paterson, N. J.; Walter R. Warne, Fayette, Mo.; Frances Moore, Washington, D. C.; Barbara J. Dimmick, Cohoes, N. Y.; and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

1845. Anthony Sturton, Quebec, P. Q.

1848. Bill Bettendorf, Culver Military Academy, Culver, Ind.; Jacob L. Chernofsky, Brooklyn, N. Y.; Jerry Johnson, Hammond, Ind.; James Smith, Lake City, Mich.

PROBLEMS FOR SOLUTION

1861. *Proposed by Alan Wayne, New York City.*

If r and R are the inradius and circumradius, respectively, of triangle ABC, show that $\cos A+\cos B+\cos C=(R+r)/R$.

1862. *Proposed by M. Kirk, West Chester, Pa.*

How long is an army column if an inspecting officer travels the length of the column and back while the column is traveling its own length. The total distance covered by the officer is $4(1+\sqrt{2})$ miles.

1863. *Proposed by M. Kirk, West Chester, Pa.*

Find the first quadrant value of θ (exact) if

$$\theta=\operatorname{arc}\cos\frac{1}{\sqrt{6}+\sqrt{2}}.$$

1864. *Proposed by Norman Anning, University of Michigan.*

If $a+b+c=0$, show that

$$\begin{vmatrix} bc & ca & ab \\ ab & bc & ca \\ ca & ab & bc \end{vmatrix}$$

is a perfect cube.

1865. *Proposed by Howard D. Grossman, New York City.*

The map of a city contains m north-south streets and n east-west streets.

(1) How many rectangles are on the map?

(2) How many shortest distinct routes are possible from one corner of the city to the diagonally opposite corner?

1866. *Proposed by Fred Jones, Scott's Corners, N. Y.*

Solve for x:

$$\sqrt{\frac{x+a}{x}}+2\sqrt{\frac{a}{x+a}}=b^2\sqrt{\frac{x}{x+a}}.$$

BOOKS AND PAMPHLETS RECEIVED

PHYSICS, A BASIC SCIENCE, by Elmer E. Burns, *Teacher of Physics (Emeritus), Austin High School, Chicago;* Frank L. Verwiebe, *Associate Professor of Physics, Hamilton College, Research Associate, Army Institute;* and Herbert C. Hazel, *Major, U. S. Marine Corps.* Cloth. Pages xii+656. 15×23 cm. 1943. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y.

GEOMETRY WITH MILITARY AND NAVAL APPLICATIONS, by Willis F. Kern, *Associate Professor of Mathematics at the United States Naval Academy,* and James R. Bland, *Associate Professor of Mathematics at the United States Naval Academy.* Cloth. Pages vii+152. 12.5×21 cm. 1943. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.75.

SPHERICAL TRIGONOMETRY, by Aaron Freilich, *Chairman, Department of Mathematics, Lafayette High School, New York City;* Henry H. Shanholt,

Chairman, Department of Mathematics, Abraham Lincoln High School, New York City; and Joseph Seidlin, *Director, Graduate Division, Alfred University, Alfred, New York.* Cloth. Pages iii+140. 13×18.5 cm. 1943. Silver Burdett Company, 45 East 17th Street, New York, N. Y. Price $1.28.

GALAXIES, by Harlow Shapley, *Director of the Harvard College Observatory.* Cloth. Pages vii+229. 14×21.5 cm. 1943. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $2.50.

GENERAL CHEMISTRY PROBLEMS, by William M. Spicer, *Associate Professor of Chemistry, Georgia School of Technology;* William S. Taylor, *Professor of Chemistry, Georgia School of Technology;* and Joe D. Clary, *Assistant Professor of Chemistry, Georgia School of Technology.* Cloth. Pages v+120. 13.5×21 cm. 1943. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.25.

ELEMENTS OF TRIGONOMETRY, by Lyman M. Kells, Ph.D., *Professor of Mathematics, United States Naval Academy;* Willis F. Kern, *Associate Professor of Mathematics, United States Naval Academy;* James R. Bland, *Associate Professor of Mathematics, United States Academy;* and Joseph B. Orleans, *Head of Department of Mathematics, George Washington High School, New York City.* Cloth. Pages x+363. 13×21 cm. 1943. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y.

STATISTICAL ABSTRACT OF THE UNITED STATES 1942. Compiled under the Supervision of Morris H. Hansen, *Statistical Assistant to the Director, J. C. Capt.* 64th Annual Edition. Cloth. Pages xxvi+1097. 14.5×23 cm. 1943. Director, Bureau of the Census, Washington 25, D. C.

LIBERAL EDUCATION, by Mark Van Doren. Cloth. Pages xi+186. 13.5×21 cm. 1943. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $2.50.

RADIO, by R. E. Williams, *Manager, School Service, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pennsylvania;* and Charles A. Scarlott, *Editor, Westinghouse Engineer.* Cloth. Pages x+282. 15.5×23.5 cm. 1943. American Book Company, 360 N. Michigan Avenue, Chicago, Ill. Price $1.48.

PLANE TRIGONOMETRY AND STATICS, by Norman Miller, *Professor of Mathematics in Queen's University, Kingston,* and Robert E. K. Rourke, *Associate Headmaster and Instructor in Mathematics at Pickering College, Newmarket.* Cloth. Pages xii+427. 1943. The Macmillan Company of Canada, Limited, Toronto.

SEASONAL EXPERIENCES IN BIOLOGY, by Sister Mary Anthony Payne, O.S.B., Ph.D., *Chairman, Biology Department, Mount St. Scholastica College and Academy, Atchison, Kansas.* Paper. 251 pages. 18.5×24.5 cm. 1943. American Book Company, 88 Lexington Avenue, New York, N. Y. Price 88 cents.

AIR NAVIGATION WORKBOOK, by Lt. A. D. Bradley, U.S.N.R., on Leave from *Hunter College, New York,* and Clifford B. Upton, *Teachers College, Columbia University.* Paper. 112 pages. 22×28 cm. 1943. American Book Company, 88 Lexington Avenue, New York, N. Y. Price 88 cents.

STATISTICS, COLLECTING, ORGANIZING, AND INTERPRETING DATA, by Raleigh Schorling, *Head of Department of Mathematics, University High School and Professor of Education, University of Michigan;* John R. Clark,

Professor of Education, Teachers College, Columbia University; and Francis G. Lankford, Jr., *Director of Research, Public Schools, Richmond, Virginia.* Paper. Pages iv+76. 16×24 cm. 1943. World Book Company, Yonkers-on-Hudson 5, New York. Price 44 cents.

An Analysis of the Arithmetic Knowledge of High School Pupils with Emphasis on Commercial Arithmetic, by Jacob S. Orleans, *Associate Professor of Education*, and Emanuel Saxe, *Assistant Professor of Accountancy*, with the Assistance of Walter F. Cassidy, *Instructor of Mathematics, The School of Business and Civic Administration, The College of the City of New York.* Paper. 144 pages. 15×23 cm. 1943. The School of Education, The College of the City of New York, N. Y.

War Savings Programs for Schools at War. Prepared by Education Section, War Finance Division. Paper. 95 pages. 14.5×23 cm. U. S. Treasury Department, War Savings Staff, Washington, D. C.

Inter-American Education—A Curriculum Guide, by Effie G. Bathurst, *Curriculum Consultant*, and Helen K. Mackintosh, *Office Representative.* Bulletin 1943, No. 2. Pages iv+66. 15×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Price 15 cents.

BOOK REVIEWS

America at Work Series: Machines for America; Power for America; Wings for America, by Marshall Dunn, *Author of "Science and Modern Progress" and "Up to Civilization,"* and Lloyd N. Morrisett, *Professor of Education, University of California, Los Angeles.* Cloth. Machines for America, xii+164 pages, 80 cents; Power for America, xii+164 pages, 80 cents; Wings for America, xii+244 pages, $1.00. 13×20.5 cm. 1943. World Book Company, Yonkers-on-Hudson, New York.

This is a most interesting and attractive set of small books for the upper elementary and junior high school students. Each book is excellently illustrated with instructive pictures and diagrams. Each short chapter is followed by a list of new words, a list of excellent questions, topics for class discussion, suggestions for short talks, investigations, directions for trips, map study and a list of good books.

Power for America is about four major topics: Steam Engines and Coal, Motors and Oil, Electric Motors and Power, and Energy for Tomorrow. Here are given in a most interesting manner the fundamental contributions for physics, chemistry, geology and social studies to the mastery of energy and its usefulness to man.

Machines for America tells of the work done by machines in a few important industries including the farm, the manufacture of glass, and the steel industry. Chapter 3 is really an excellent chapter on elementary physics, the discussion of simple machines.

Wings for America is a book Johnnie will not study at home; if he takes it home Dad will have it. It tells briefly the story of the airplane, its early history and its development to the present time, discusses types of planes and their uses, gives the important ideas the airman needs to know about the weather, teaches global geography and maps, and gives a view of the planes of the future.

G. W. W.

FACTORS AFFECTING STUDENT ACHIEVEMENT AND CHANGE IN A PHYSICAL SCIENCE SURVEY COURSE, by Waldo Lyle Brewer, Ph.D., Teachers College, Columbia University, Contributions to Education, No. 868. Cloth. 78 pages. 14.5×23 cm. 1943. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $1.60.

In this study the author determines the effect of survey science courses on students who were enrolled in them at Queens College, New York City. In studying the types of achievement and change made by the students, an attempt is made to answer the following questions:

1. To what extent are factors such as intelligence, initial information, sex, high school attended, and high school courses in science and mathematics related to student achievements, increases in information, and changes in opinions?
2. To what extent can the final grade marks of students be predicted from data available at the beginning of the survey course?
3. How do different lecture and recitation instructors differ in their influences on student achievements, increases in information, and changes in opinions?
4. How well.do final grade marks divide students of the survey course into distinctly different groups? How do failing students in the survey course differ from those who receive passing marks?

Those interested in survey courses will find the answers to these questions of great value since they should have a bearing on various types of survey courses in many different school situations throughout the country. The results of the study should also be of use to those interested in evaluating and improving objectives, content, teaching methods, and standards for student achievement in survey courses. They can also be of value to the student who plans to take a survey course and to his advisers in estimating the probable degree of his success in the course and in estimating what benefits he can derive from the course.

In Chapter I the author sketches briefly the development of the physical science survey course. In Chapters II, III, and IV a number of different types of achievements and changes made by students in the survey course are discussed, and the relationship of certain factors to these achievements and changes are studied.

Following the summary of the study which appears in Chapter V is an excellent bibliography which should be of value to those interested in the subject.

CHARLES A. STONE

THE PRACTICAL OUTLINE OF MECHANICAL TRADES FOR HOME STUDY, edited by William L. Schaff, *Assistant Professor of Education, Brooklyn College*. Cloth. Pages xxii+954. 21×13.5 cm. 1942. Garden City Publishing Co., Inc., Garden City, N. Y. $3.95.

This book is designed for home study by those whose background is weak in mathematics, science and industrial arts, and who wish to take advantage of opportunities in the mechanical trades. Although it will not make an electrician or a patternmaker of a man, it will give him part of the desirable background for such work.

It is necessary to examine the table of contents to gain an appreciation of the scope of this book. The chapter headings are: Fundamentals of Arithmetic, Elements of Algebra, Practical Geometry, Shop Trigonometry, Mechanical Drawing, Applied Physics, Strength of Materials, Practical Chemistry, Materials of Trade and Industry, Machine Elements,

Machine Shop Practice, Woodworking and Patternmaking, Metal Trades, Electrical Trades, Glossary, Tables, Index.

It may be noted that there are three general sections to the book, the first dealing with mathematics, the second with practical sciences, and the third with four trades as given above. The chapters of the book are to be studied in order, a sequence of topics having been set up.

The section on Mathematics seems the strongest. It is practical, and there are numerous exercises for which answers are given. Conscientious study of these chapters is certain to be helpful.

The section on Mechanical Drawing is also excellent. Anyone who has no background in this field will be benefited by carrying out the exercises in reading and constructing mechanical drawings.

The chapter on Physics is weak. A conventional physics course has been condensed to the point where almost nothing is said about a great deal. Its subject matter is that of overflow buckets and bimetallic expansion-apparatus rather than of commonplace materials. It is doubtful whether the average home worker can appreciate this chapter without an instructor to show its practical applications. Illustrative problems are used to show mathematical relations but no practice problems are given and therefore this feature has little value.

More discrimination in the selection of subject matter for the chemistry section resulted in a considerable amount of practical information. The subject of chemical equations is touched on briefly so that a worker will have an appreciation of the meaning of chemical formulas, even though he will not be able to set up his own.

Of the chapters on trades, this reviewer is qualified to judge only one, that of the electrical trades. As stated before, the book will not make an electrician of a man. He may learn to recognize by name such things as outlet boxes, hickeys, and conduits, he will learn that there are such things as separately-excited generators, three-phase electrical systems, and repulsion-induction motors, but he will not learn to install the former class of things or will he have much appreciation of the latter. More specialized books are needed for this purpose.

It is doubtful whether science and mathematics teachers will find the book of service in their teaching unless they are preparing boys for entrance in the mechanical trades. However, a teacher who wishes to round out his own background and review his practical mathematics, will find the book useful for home study.

WALTER A. THURBER

PRACTICAL PHYSICS, by Marsh W. White, Ph.D., *Editor, Professor of Physics;* Kenneth V. Manning, Ph.D., *Assistant Supervisor of Physics Extension;* Robert L. Weber, Ph.D., *Assistant Professor of Physics;* R. Orin Cornett, Ph.D., *Lecturer in Electronics, Harvard University;* and Others on The Physics Extension Staff. Prepared under the Direction of The Division of Arts and Science Extension, The Pennsylvania State College. Cloth. Pages x+365. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.50.

During the recent war months many abbreviated textbooks of physics have appeared. These texts have attempted to shorten the physics course to fit the needs of some particular speed-up training program. Since many of these programs have developed around the special needs of a community or war project, it has been found that many of the texts are specialized in certain fields but lacking in others, and thus, finding but little use in other training programs.

The book reviewed herein was also written by a group of men interested in a war training course, but since this course was one for general foundational training in physics, the usual overemphasis of one particular field does not appear. The authors have made a very successful selection and condensation of those fundamental principles of physics most likely to be needed in various industries and in many of the technical branches of the Armed Services.

This text should adequately fit the needs of shortened introductory courses in physics at any mature age level. It employs only the simplest algebraic and trigonometric formulation. The authors, however, have not omitted the equations and problems that are so vital to the functional acquisition of physical principles, but have introduced the more mathematical concepts of mechanics after the student has had time to orient his thinking to the scientific method. The definitions are clearly and accurately stated both in words and in equation where needed. The equations are given with word explanation rather than much algebraic derivation, and their utility is illustrated by simple worked-out numerical problems. The problems at the end of the chapters are graded in difficulty. The more difficult problems seem to be above the general level of difficulty of those illustrated in the text, but this would seem a desirable feature to hold the interest of those of better background of experience and mental training.

The arrangement of the material is novel in that heat is introduced before mechanics. This does not seem to lose much of the sequence of definition of units, since the heat units here defined are those that were built up independent of the mechanical point of view. The tie between heat energy and mechanical and electrical energy is made after the study of these subjects.

A significant feature of this text is the incorporation of the discussion of the accuracy and uncertainty of measurement, and the importance of significant figures in computation as based upon the degree of refinement of measurement. This discussion is tied in with suggested laboratory exercises in measurement. Each chapter has a suggested experiment at the end which illustrates the use of the principles of the chapter. This might be sufficient laboratory for the general course but would need to be augmented by additional laboratory where the student is preparing for laboratory or measurements work in some special field. These special courses usually parallel the general course.

The book contains a generous number of clear and instructive diagrams and photographs. The use of italics to designate the new and significant words to be added to the science vocabulary is well done.

It seems that the authors have succeeded admirably in arriving at their aim of a concise, fundamental physics. The book should give the inquiring student sufficient training in the foundational principles of physics to fit him for further work in practical and specialized fields.

H. R. VOORHEES
Wilson College, Chicago

HEAT AND THERMODYNAMICS, by Mark W. Zemansky, Ph.D., *Associate Professor of Physics, College of the City of New York*. Second Edition. Cloth. Pages xiv+390. 14.5×22.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $4.00.

The author has made a thorough revision of this text that has met with such favor in the intermediate fields of theoretical physics, chemistry, and engineering. The general characteristics of the earlier edition have been maintained, but attention has been given to the revision and addition of

many problems as well as many topics. The new topics include convection, entropy and nonequilibrium states, second order phase transitions, superconductivity, heat capacity of reacting gas mixtures, and le Chatelier's principle.

The author has maintained the macroscopic point of view since he feels that at this level the student can grasp the subject better in terms of measurable quantities. The mathematical foundation necessary for this point of view requires only the calculus, while the microscopic approach would require a background of statistical mechanics and is better introduced at a more advanced level than is intended for this text. There is, therefore, no development of the kinetic molecular theory.

Some of the mathematics is beyond the elementary course in calculus but where it is employed sufficient development is given so that the student should have no difficulty in following.

The latter half of the text deals with the practical applications of the principles of thermodynamics. Methods of measurement are explained and experimental results are tabulated where it is desired to point out significant relationships.

H. R. VOORHEES

MATHEMATICS FOR THE SHEET METAL WORKER, by Clayton E. Buell, B.S., M.Ed., *Instructor of Related Trade Mathematics, Science, and Drawing Apprentice School, U. S. Navy Yard, Philadelphia, Pa., and Edward Bok Vocational School, Philadelphia, Pa.* Cloth. Pages vii+199. 13×20.5 cm. 1943. Pitman Publishing Corporation, 2 West 45th Street, New York, N. Y. Price $2.00.

A textbook intended for use by students in vocational and apprentice training classes. It is well adapted to use as a home study textbook for persons already employed in the trade and seeking to gain advancement.

The numerous, interesting illustrations are taken from the sheet metal shop. Explanations are clear, concise and not too difficult. All of the necessary branches of mathematics are covered for both the practical sheet metal worker as well as the advanced student. Each new theory is followed by a number of typical shop problems. The use of problems taken from the fields of aviation and shipbuilding help to stimulate interest in the work. Answers are provided in the rear of the book.

The writer being a tradesman as well as an educator has enlisted the aid of navy specialists in the field of shipbuilding. The discussion of ventilating duct design and the factors to be considered as well as the calculations required are very practical. The student should be able to calculate the volume of air required; the velocity needed and the size of the duct necessary if he knows the number of turns in the duct and its length after studying the discussion of ventilating problems.

Problems involving the plotting of airfoils are certainly modern and unusual. The methods suggested for the calculation of the area of irregular shaped surfaces are most interesting and those of the tradesman. There is a splendid discussion of the calculation of bend allowances.

ROGER J. WEAVER
George Washington High School
Indianapolis, Indiana

EDUCATORS GUIDE TO FREE FILMS, Third Edition, Compiled and Edited by Mary Foley Horkheimer; and John W. Differ, M.A., *Visual Education Director, Randolph High School, Randolph, Wisconsin.* Paper. Pages 169. 2.8×21.3×27 cm. 1943. Educators Progress League, Randolph, Wisconsin.

With the steady improvement in the quality of commercially sponsored motion pictures within recent years, this volume should prove a valuable adjunct to the school's library of visual aids source materials. The index is divided into four main divisions: motion pictures listed by subject areas, alphabetical listing, slide films by subject areas, and source index. Film descriptions are reasonably complete—including the usual physical data plus an indication of the content. Approximately 2,000 subjects are listed covering both 16 mm. and 37 mm.—sound and silent—offerings.

The Editors' suggestions regarding the use of the index and the film titles therein constitute sound policy in utilizing films in general in the classroom, but they are particularly pertinent in the case of gratis offerings. One must bear in mind—in using the latter—that objectionable bias or advertising content may be present—although cause for concern in this area is diminishing. The sponsored film is rapidly becoming a vital educational tool. This volume should indeed assist in its use.

R. E. SCHREIBER
Stephens College

METHODS OF TEACHING IN TOWN AND RURAL SCHOOLS, by E. L. Ritter and L. A. Shephers, *The Iowa State Teachers College.* Cloth. Pages xiii +492. 13×20.5 cm. 1942. The Dryden Press, Inc., 103 Park Avenue, New York, N. Y. Price $2.40.

The volume on *Methods of Teaching in Town and Rural Schools* will fill a long felt need for some material in methods that is particularly adaptable to teaching in these areas. The book contains many practical suggestions on general methods of teaching and gives special emphasis to methods in the following fields: Reading, Language, Spelling, Writing, Arithmetic, Social Studies, Science, Music, and Art. In addition to the specific suggestions on methods of teaching the above subjects, some general techniques in classroom methods and procedures are also discussed. The book contains two particularly good chapters covering Measurement in Teaching and "Development of Units" of work. The authors are to be commended for the large number of practical suggestions which they have offered in the text. It is one volume that does not deal in theory but gives the classroom teacher a practical guide for improving her instructional ability. It could well be a part of the professional library of every elementary school teacher.

W. A. EGGERT
De Paul University

RADIO EDUCATION PIONEERING IN THE MID-WEST, by Albert A. Reed, LL.D., *Formerly Deputy State Superintendent of Public Instruction, Lincoln, Nebraska; Director-Emeritus, University Extension Division, University of Nebraska; Professor Emeritus, Secondary Education, University of Nebraska.* Cloth. 128 pages. 12×20 cm. 1943. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $2.00.

This volume presents a comprehensive review of the early work in radio education in the middle western area of the United States. Special attention has been given to the development of radio education in the following states: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota. A chronological development of radio education in the various institutions in these states is presented. The book will be of particular interest as historical material inasmuch as the pioneer work in radio education is carefully outlined. It also reveals the trends in types of programs presented for the past two decades. Mr. Reed is to be commended for his painstaking efforts in bringing together this valuable information.

W. A. EGGERT

ELEMENTARY AVIGATION, by L. E. Moore, *Holder of C.A.A. ground instructor certificate No. 53562, Teacher of mathematics, Far Rockaway High School, New York City.* Cloth. Pages vii+222. 15.5×22.5 cm. 1943. D. C. Heath and Company, Boston, Mass. Price $1.60.

This brief text attempts to cover the topics of airplane instruments, meteorology, contact flying, dead reckoning, radio and celestial navigation at the level of high school students who have had only elementary algebra and plane geometry, intermediate algebra being taken simultaneously. The treatment is divided into ninety lessons, including nine review lessons on the various topics, and eight general review lessons followed by two final examination periods. Each lesson is followed by from six to twenty discussion questions or problems. Answers to the problems are not included.

It seems doubtful that high school students can cover the amount of material included in any but the most superficial manner. For example, only one lesson is devoted to the solution of the astronomical triangle, although this requires the use of logarithms of trigonometric functions. Although in the preface the author states by implication that trigonometry is not a prerequisite, on page 150 he refers to formulas already used in plane trigonometry. Bound with the text are four place natural trigonometric functions, also four place logarithms of numbers and of trigonometric functions. Specimen pages from the Nautical Almanac and from the Air Almanac are included.

One might in spots question certain unqualified statements, as for example, ". . . true airspeed is always greater than the indicated airspeed. . . ."

CECIL B. READ
University of Wichita

PILOTING AND MANEUVERING OF SHIPS, by Lyman M. Kells, Ph.D., *Associate Professor of Mathematics;* Willis F. Kern, *Associate Professor of Mathematics;* and James R. Bland, *Associate Professor of Mathematics, All at the United States Naval Academy.* Cloth. Pages xviii+181. 15.5×23.5 cm. 1943. The McGraw-Hill Book Company, 330 West 42nd St., New York, N. Y. Price $2.00.

NAVIGATION, by Lyman M. Kells, Ph.D., *Professor of Mathematics;* Willis F. Kern, *Associate Professor of Mathematics;* and James R. Bland, *Associate Professor of Mathematics, All at the United States Naval Academy.* Cloth. Pages xx+479. 1943. The McGraw-Hill Book Company, 330 West 42nd St., New York, N. Y. Price $3.75.

Except for very minor variations, the text on navigation is identically the same as the treatment of these topics in the smaller book on piloting. The material on piloting, often found scattered in larger texts on navigation, is here condensed in one text. Both books have very excellent pictures and diagrams; both provide many exercises, graded in difficulty from simple ones to complicated situations met in actual practice.

The scope of the material treated can be indicated by listing chapter headings: In the book on piloting we find Fundamental Mathematics for Pilots; Instruments; Piloting; Ship and Plane Maneuvers; Definitions, Sailings, Mercator Chart; Range Finder; Logarithms (the last three appear as appendices). In addition to these topics, the text on navigation has chapters on Charts; Navigation Aids, Rules of the Road, Tides and Currents; Review of Spherical Trigonometry; Nautical Astronomy and Star Identification; Time; Air Almanac; Meridian Altitude; Fix; The Hagner Planetarium.

The treatment seems very clear and complete, illustrative examples are worked out in detail and excellent illustrations add greatly to the interest. Even though neither book is a suitable text for any course there should be available for student reference a copy of the book on navigation—in no better way can students see practical applications of mathematics in a special field.

Unfortunately the texts are marred by a few details. The authors tend to utterly disregard the accuracy which may be obtained with given data. Answers to trigonometric problems tend to be quoted uniformly to seconds and five significant figures, irrespective of whether the given angles were to the nearest degree or nearest second, or whether linear measures were accurate to two or to five significant figures. Again, one finds an inexcusably large number of errors in computation. For example, on page 418 there is an error in an illustrative example (the same example, with the same error, has appeared in at least three other books by the authors); problem 31 on page 426 has an erroneous answer, again repeated from previous texts; problem 4, page 78 seems to be in error. The list might be continued, it will simply be noted that if the books are used as a text, students should be warned that answers are likely to be wrong.

CECIL B. READ

WASHINGTON HAS NO ANSWER

Virtually all employees in manufacturing industries received wage increases totalling 15% between January 1941 and May 1942 to make up for the rise in living costs during that period.

But for the one million teachers and 14,000,000 other "white-collar" and professional workers no such adjustment has been made, with some exceptions.

These facts were forcibly brought to the attention of Washington—Congress, War Labor Board, OPA, and the White House—by a series of front-page news-articles by veteran correspondent Louis Stark.

Seeking to arouse Washington to the plight of 15,000,000 "forgotten people," Mr. Stark asked members of Congress and Federal officials how this large group can avoid "the squeeze" resulting from rising living costs and static salaries.

Here are some of the results:

OPA Administrator Bowles: "There is only one way to protect this group. Stop prices from rising. That is what price ceilings are for."

Secretary of Labor Perkins: "Passage of the subsidy bill will help these 15,000,000 unorganized workers."

Sen. Harry F. Byrd of Virginia: "I'm opposed to subsidies. . . . I don't know what the answer is."

Sen. Bennett C. Clark, of Missouri: "If I had a solution I would shout it from the housetops. Teachers and white collar workers generally, as well as fixed-income people, always have a decrease in their income at times like these because their wages do not go up and at the same time they pay higher taxes and more for the necessities of life."

Sen. Ralph Brewster, of Maine: "These people (teachers, etc.) should be able to get a judicial determination of their own. All they should have to do is to write a letter to get their increase based on the Little Steel formula. Today the formula applies only to those who can make a noise."

Sen. Thomas of Utah, whose Federal Aid to Education Bill, now before the Senate Committee on Education and Labor, provides a means for raising sub-standard teacher salaries, did not mention his proposal specifically, since the question applied to all "white-collar" workers and not teachers exclusively. He said: "The only answer is that no matter how hard you are hit someone else is hit harder."